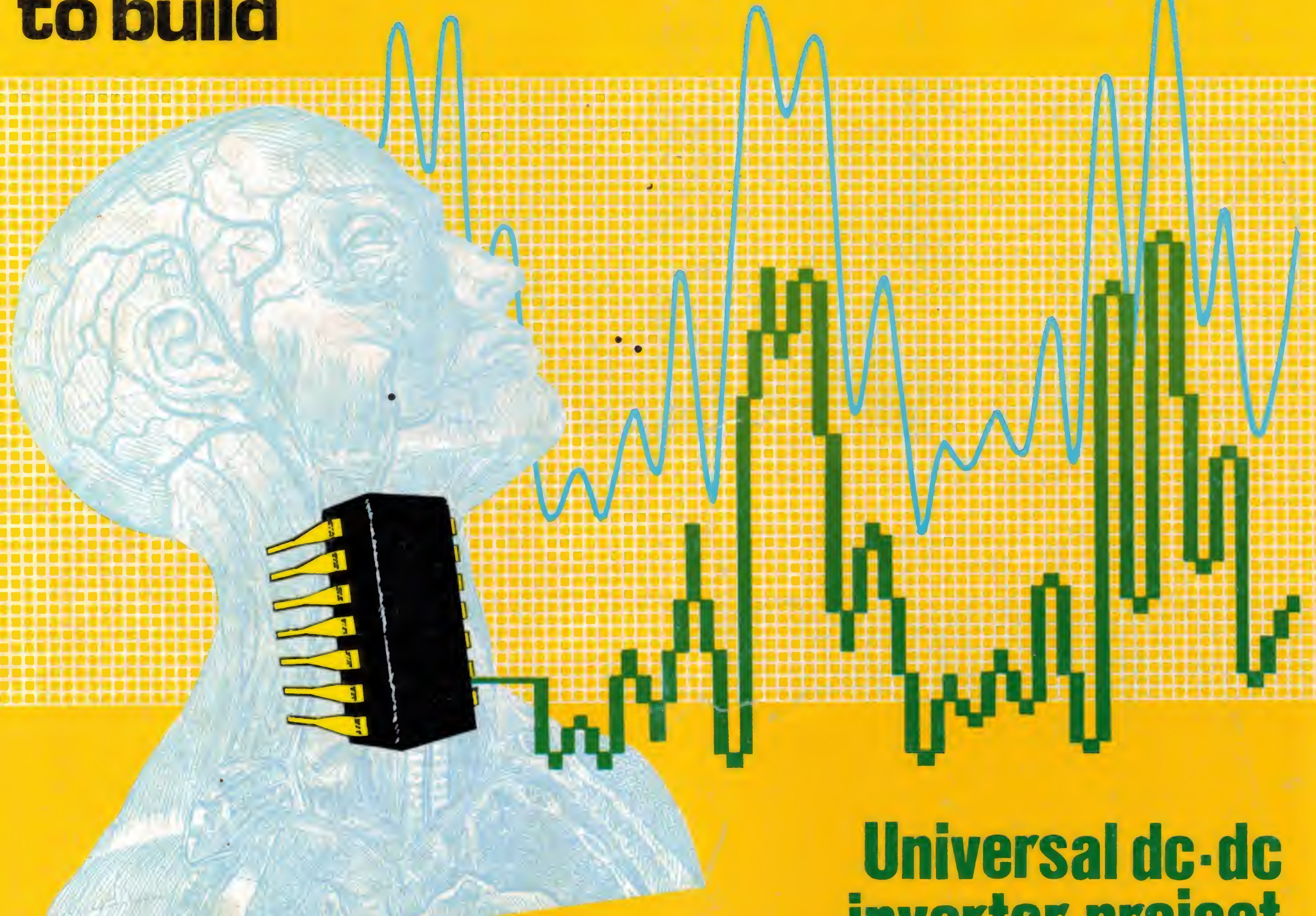
SEPT 1982 $2.15* NZ $2.50

eti ELECTRONICS TODAY INTERNATIONAL

WIN A Microprofessor Microcomputer

SPEECH SYNTHESISER to build



Universal dc-dc inverter project

Build a 'Photophone' light beam transciever

Nakamichi High-Com II noise reduction system reviewed

The average hi-fi designer versus the human ear.

The human ear forms part of a sound receiving system that outperforms the best audio equipment known to science.

Capable of interpreting a dynamic range of 120db or 10 octaves, it has double the capability of any man made electronic equipment.

The ear can discern direction, coloration and musical within a complex detail rendition of a 50 piece orchestra in a manner no electronic equipment is able to do.

It is, in short, a sophisticated piece of equipment that should represent the most stimulating challenge to any designer of audio equipment.

Unfortunately it's a challenge that's largely ignored. Which is why in most stereo

systems handling power and volume are substituted for subtlety and frequency response. Vector Research however is one of the few exceptions. Developed by a team of highly experienced audio engineers who were tired of compromise, Vector Research represents a new standard in high fidelity excellence.

Discussing the Vector VRX 9000, *Stereo Review* states "The receiver surpassed virtually every one of its performance specifications... it sounds as good as it looks, which is saying a lot..."

High Fidelity states "a receiver with such sophisticated performance and functions demands attention."

Popular Electronics on the Vector VCX 600 cassette deck, "Lower Flutter readings than those of the VCX 600 are hard to find... while not cheap, it affords excellent value." *Hi-Fi Buyer's Review* sums up.

"Vector Research is a newcomer to the audio scene, but if the VCX 600 is any guide, this company should be very successful."

If then you are an audiophile whose interest goes beyond famous names and shiny knobs then you owe it to yourself to learn more about Vector Research.

Dear V.R., In my book, beauty is in the ear of the beholder. Send me the test reports and the name of my nearest stockist.

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Address ____________________

____________________ Postcode __________

Keio International Pty. Ltd.
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Telephone: (03) 64 3546.

KO 404 ETI

Vector Research. A fraction better than excellent.

ELECTRONICS TODAY INTERNATIONAL

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Roger Harrison
Editor

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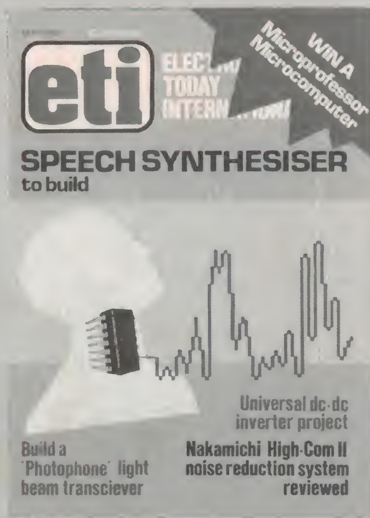


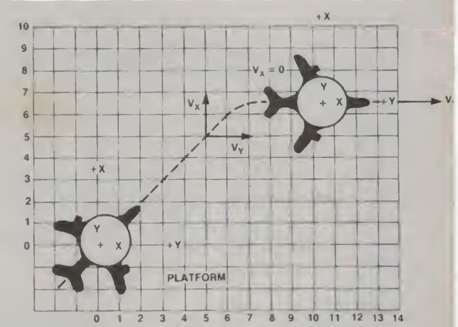
COVER

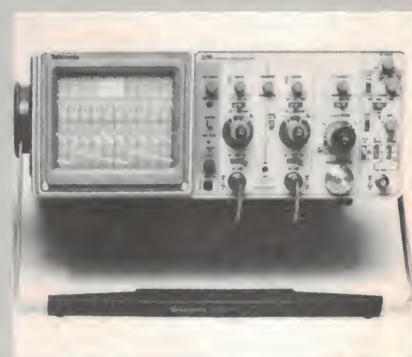
Feature project this month is the Speech Synthesiser, which starts on page 81. This project produces 'electronic speech' by the 'waveform digitisation' method — which the cover abstract is meant to represent.

Cover design by Ali White

news

features





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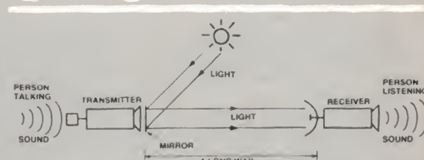

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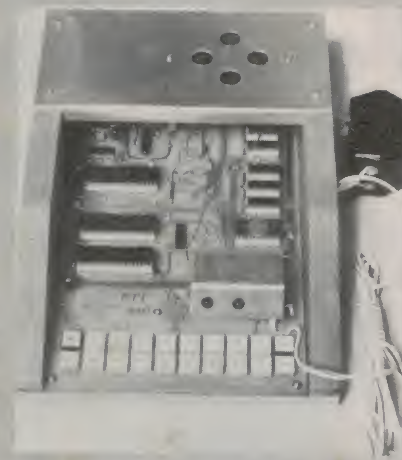


'660 PROGRAM POTPOURRI
A grand assemblage of programs for our popular ETI-660 Learners' Microcomputer! Now you can try a host of great programs like Dot Destroyer, Meteor Storm, Block Puzzle, Black Jack, Noughts & Crosses etc. An issue not to be missed by the '660 owner or CHIP-8 enthusiast!

EPROM PROGRAMMER FOR THE 2650 S100 BOARD
The ETI-685 2650 S100 computer board (Dec. '81) features three programmable ports run by an 8255 PPI. This EPROM programmer makes use of this facility, although it can be used with any microcomputer which has three 8-bit ports available. The unit is self-contained and construction is straightforward. A full program listing for use with the ETI-685 is included.

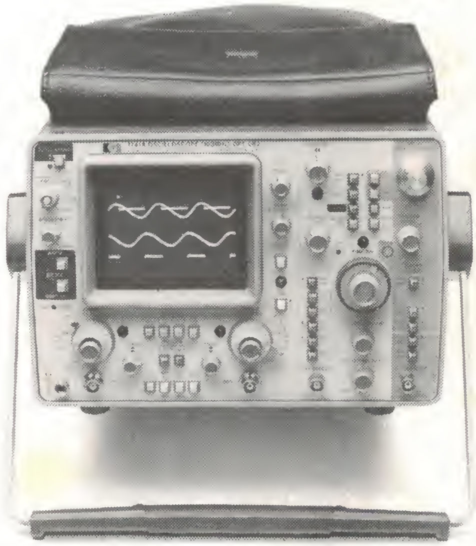
LOUDSPEAKER PROTECTOR
When we described the ETI-499 General Purpose MOSFET Amp module (March issue), we made mention of a loudspeaker protector project. This is it. This simple module can be used with very high power amplifiers, or even low power amplifiers. It requires no power supply yet provides complete protection.

XR2240 SUPER TIMER
We've had to hold this one over due to lack of space. This Lab Notes describes characteristics and applications of the recently released XR2240 timer chip that can produce accurate timing periods ranging from seconds to . . . years!

VECTOR RESEARCH VR5000 FM-AM RECEIVER
Vector Research Products are new to Australia, and this 'no frill', top-line American-made product has a number of interesting and unusual features. Full report from Louis Challis.

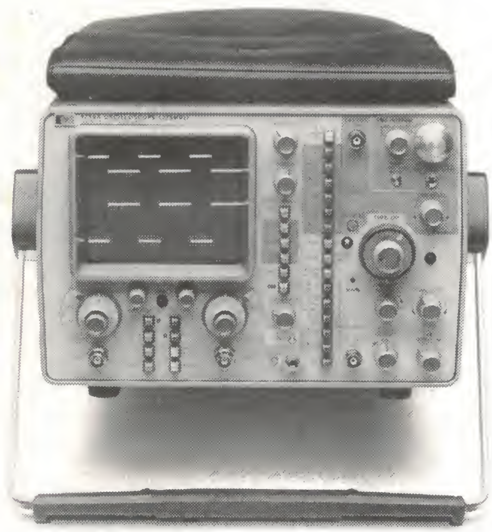
Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

Three ways of measuring a fast pulse without visiting your doctor.



Variable Persistence Storage.

Model–1741A, is the best selling 100MHz general purpose storage scope on the market. It combines 200 cm/μsec writing speed with features such as the babysit mode, auto erase, and auto store. These features mean its ease of use is unequalled. Models 1744A, 1727A are optimized for capture of super fast single shot or low rep rate pulses. Writing speeds of 1800 and 2000 cm/μsec respectively are guaranteed.



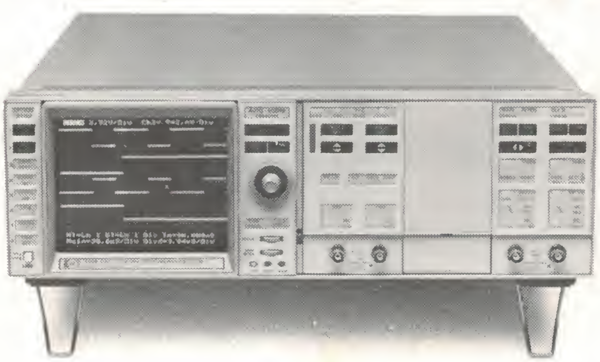
High Frequency Scopes.

At Hewlett-Packard we've always had our fingers on the pulse of innovative technology. Our HP 1700 range of oscilloscopes are no exception. Bandwidths of 100, 200 or 275 MHz offered by our models 1740/1742/1743/1715/1725/1722, coupled with excellent trace quality means reproduction of pulses or wavetrains with fidelity. The Dual delayed timebase (or delta time) feature found on some models incorporates two intensified trace markers and allows more accurate measurement of pulse characteristics such as risetimes, period and phasing.

Automated Scope Set Up and Operation.

The Auto Scope feature of our model 1980 gives it the ability to auto range and display any input signal. This makes display of a repetitive pulse a breeze. Single shot applications can be handled by using the 19860 digitizing plug in while 4 channel operation is obtained by plugging in the 1950A input module.

The 1980 system offers the user greatly improved productivity in the fields of Production Test (manual or automated), Calibration labs and Research and Development.



Service and Calibration.

All HP's current generation oscilloscopes have been designed with ease of access and repair in mind. We will carry out most scope repairs for a fixed fee, so you avoid the uncertainties of waiting for a quote. Annual service or calibration contracts can be arranged so that you can budget for your support needs a year ahead.

If you elect to perform your own repair work you can be confident you have good documentation to work with. The quality of our operating and service manuals is well known throughout the electronics industry; and we maintain in Australia, a large supply of scope spares.

Contact your nearest HP office for data on any of our oscilloscopes or for details of our fixed price/contract repair program.

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Just check the features. We are sure that you will calculate that the "Voyager" represents outstanding value!

FEATURES

- INSTANT FUEL CONSUMPTION IN LITRES/100KM AND MPG!! (MOST OTHERS HAVE ONLY ONE OF THE ABOVE) JUST SWITCH FROM ONE TO THE OTHER AS YOU DRIVE ALONG.
- INSTANT SPEED, TIME AND OTHER FUEL DATA.
- VISUAL AND AUDIBLE EXCESS SPEED ALARM.

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The "Voyager" comes complete with an unbelievable array of mounting configurations, on dash, under dash or stalk mount. ALL installation hardware is supplied (even a roll of insulation tape!) as well, of course, as the speed and fuel sensors. A lavishly illustrated installation manual is provided as well as a comprehensive operators manual. If you do not want to install the unit yourself we can do this for you for a guaranteed $39.50*. (A few exotic cars excluded!). A typically competent EA/ETI reader would do the job in 3-4 hours.

* Sydney metropolitan area only.

VOYAGER OPERATING FEATURES

Instantaneous fuel consumption from sec to sec as you drive.

DISPLAY: 5 digits 0.4" high.

Distance travelled since the Log computer was last re-set.

Two programmable speed alarms

Fuel used since the Log computer was last re-set.

Straightforward calibration.

Metric and Imperial conversion.

Average fuel consumption since the Log computer was last re-set.

Light sensor automatically adjusts brightness of display.

Average speed over the trip.

Instantaneous speed as you drive from sec to sec.

Elapsed time since the Trip computer was last re-set. Can be used as a split lap timer.

Clock with 12 hour format. Can be operated as a stopwatch.

Distance travelled since the Trip computer was last re-set.

Overall dimensions: 20cm x 7.1cm (9cm deep).

Lights left on alarm.

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Apple sours Oranges

Apple Computer Inc. has filed a number of lawsuits overseas, notably in Taiwan, Hong Kong and New Zealand, in an effort to stop the manufacture and export of Apple II personal computer 'imitations'.

In New Zealand, Apple obtained an injunction against Orbit Electronics which Apple claimed was passing off "Orange" computers from an unknown Taiwanese manufacturer as Apple II computers.

It is also common knowledge that Apple II imitations are available in Australia and investigations are continuing, as is the case in Japan and Singapore.

In Taipei, early in July, Apple brought a civil action under Taiwan's copyright laws against 'Sunrise' computer, maker of the "Apolo II" computer.

As a first step in this action, in accordance with Taiwanese law, Apple seized as evidence several Apolo computers during a surprise raid on a 'Sunrise' facility in Taipei.

Apple also plans to take similar action against another manufacturer in Taiwan. The government of Taiwan has helped prevent the export of Apple II copies, according to the company.

In Hong Kong, Apple filed a civil action under local patent laws against a small manufacturer selling Apple II copies, a number of which were seized as evidence in a surprise raid similar to the one in Taiwan. Sales and purchase records of the company were also seized.

Because patents and copyrights are enforceable in Hong Kong, Apple expects to halt all manufacturing and selling of copies there.

Apple has registered its trademarks and copyrights with US customs authorities and expects that 'bogus' Apple products will be confiscated by the US government at the port of entry.

Guide to CSIRO research

A comprehensive guide to CSIRO's research activities throughout Australia, containing descriptions of more than 700 research programs and sub-programs, was released late in June.

In clear, non-technical language, it outlines research programs being tackled by the CSIRO and the implications of research findings.

The latest edition of the research guide contains programs arranged under subject matter headings within four main sections covering rural industries, mineral, energy and water resources, manufacturing industries and community interests.

The names, addresses and telephone numbers of the people to contact for further information about any research topic are also included.

Three index listings are included: one which lists programs and sub-programs, one listing personal names, and one listing subjects.

Copies of the publication, titled 'Directory of CSIRO Research Programs', are available for $15 (postage included) from the CSIRO Editorial and Publications Service, P.O. Box 89, East Melbourne Vic. 3002. Cheques accompanying orders should be made out to 'Collector of Moneys, CSIRO'.

New look at the milky way

CSIRO radio astronomers in Sydney have used a new technique to discover that the Milky Way was part of a grand spiral galaxy with four catherine wheel arms trailing over a distance of more than 100 000 light years.

The research, carried out using the four-metre radio telescope at Epping (NSW), had uncovered previously unknown facts about the galaxy in which we live. The Milky Way, as normally seen, is an edge-on view of our galaxy.

"The new technique has allowed astronomers to observe the massive clouds of molecules between the stars from which new stars are born," the Minister for Science and Technology Mr. Thomson said when releasing the announcement.

"Using the four-metre radio telescope, researchers have penetrated the interstellar dust which normally obscures the light from distant stars."

"Radio waves, penetrating the dust, can probe every part of our galaxy and have enabled radio astronomers to 'piece together' the grand design of the Milky Way."

Since the 1950s, radio astronomers at CSIRO's Division of Radiophysics have played a leading role in this quest.

The team of CSIRO scientists comprised Dr. Brian Robinson, Dr. Jim Caswell, Dr. Raymond Haynes, Dr. Dick Manchester and Dr. John Whiteoak. Collaborating in the project have been Professor Bill McCutheon from Vancouver and Chris Rennie from the ANU's Mount Stromlo Observatory.

The researchers have taken radio measurements of the molecular clouds in our galaxy which delineate the spiral arms. These are normally highlighted optically by hot, young stars and surrounding ionized gas.

"These measurements have been convincingly made since 1980, with supporting observations made at Columbia University in the United States," Mr. Thomson said.

"Complementary radio observations of ionized gas, made over the past 10 years at Parkes in New South Wales, have been vital in understanding these observations," he said.

The scientists presented their research to international conferences in Holland and Greece last month.

New Fluke 4½-digit handheld

Fluke's 8060A, the newest in their range of DMMs, is a handheld, microcomputer-based 4½-digit multimeter that includes true RMS measurements for ac signals to 100 kHz, frequency measurements to 200 kHz and resistance measurements to 300 M.

It also has the ability to store any measurement as an offset (a positive or negative relative reference value).

Voltage measurements can be directly displayed in dBm referenced to 600 ohms, or in relative dB.

Continuity testing (with selectable visual/audible indication), conductance and constant current source diode testing are also included.

A multiplexed LCD display provides special function annunciation, low battery (20%) warning and a power-up self-diagnostic indication.

The Fluke 8060A is powered by a standard 9-volt alkaline battery (170 hour continuous operation) or optional ac battery eliminator. The Fluke 8062A, a companion model, comes without the Hz, dB and conductance functions.

Availability is from stock through Elmeasco offices in all mainland states, or through major electronic retail outlets.

RIFA get Precision Monolithic Inc.

During a recent visit, Mr. Steve Pass, Vice President, Sales, of Precision Monolithics Incorporated, announced the appointment of Rifa as sole Australian distributor for the P.M.I. range.

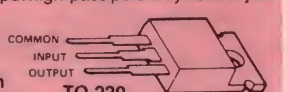
P.M.I. manufactures a wide range of high quality, high performance linear integrated circuits including operational amplifiers, comparators, matched transistors, voltage references, D/A converters, multiplexers/analogue switches, sample-and-hold circuits as well as telecommunications circuits.

P.M.I. was established by Bourns Inc.in 1969 and since that time has become recognised, world-wide, as a leader in high performance IC's. For further information contact Peter Duddy, RIFA Pty Ltd, 202 Bell Street, Preston Vic. 3072. (03)480-1300.

NOTES & ERRATA

ETI-499 Mosfet amp, March '82. Some people have had trouble with the output offset voltage adjustment, being unable to reduce it to 10 mV or less. This can be fixed by changing R2 from 100k to 33k. The input high-pass pole only rises to just under 20 Hz, which is OK.

Circuit File: power supplies, April '82. On page 20 the pinout of the TO-220 79xx voltage regulator shows the **common** and **output** pins reversed. The correct pinout is shown here.



TO-220
79xx –ve voltage reg.

MINITOOLS CONTEST WINNERS

The contest featured in our April issue (page 13) offered a complete Minitools toolkit as first prize plus a selection of tools for second and third prizes. We had a hard time choosing three winners from the huge number of entries, but after some deliberation, we managed.

Contestants had to answer four questions and tell us in 50 words or less what features of Minitools attracted them and how this applied to their intended application.

Here are the correct answers to the four questions:

1. When drilling holes in a pc board, stability is essential to avoid breaking the very small drill bit. Thus, it would be best to hold the pistol drill in —
- [ ] your hand.
- [ ] a vice.
- [x] the drill stand clamped to a bench.
- [ ] the dog's mouth.

2. When cutting a large hole in a panel to fit a meter, the hole is quickly and neatly cut by —
- [ ] drilling a circle of holes and filing around them.
- [x] using a jig saw.
- [ ] using a 'nibbling' tool.
- [ ] getting the dog to chew it out.

3. Power tools for hobbyist use are most safely powered from —
- [ ] a 1500 V dc supply.
- [ ] a 240 V ac supply.
- [ ] a 415 V ac supply.
- [x] a 12 V dc supply.

4. A flexible shaft unit for a drill is most useful for —
- [ ] doing dental work on the dog.
- [x] drilling in awkward places where a pistol drill won't reach.
- [ ] drilling around corners.
- [ ] drilling something you're too lazy to hold in a vice.

First prize of a Minitools Workshop Kit went to:

Peter Mann of Robinvale, Victoria.

Here's what he said:

"I am a hobbyist and I make my own cases and pcbs for projects. All the features of Minitool tools would make the task of drilling and deburring holes, shaping and smoothing hardware, drilling pcbs — even cutting the pcb from blank material, a lot easier, faster and more accurate."

Second prize of a pistol drill, drill stand, flexible shaft and power pack went to:

I. Bernsteins of Mount Pleasant, West Australia.

He had this to say:

"Minitools' features are useful to me in robotics. Their small size allows them to be used where other tools can't fit and to make parts too delicate for normal power tools. The 12 V supply allows work to be done safely, even 'in-flight' using the robot's battery."

Third prize of a pistol drill, orbital sander and power pack went to:

Peter Furnell of Woollahra, NSW

for his ingenious audacity! Read this:

"I am in the business of making hand-crafted electric harps for Leprechauns. Minitool tools are ideal for these instruments because of their small *scale* ..!"

"(The Leprechauns use the harps to play a new kind of Irish rock music called Sham Rock.)"

Thanks to the many, many readers who so enthusiastically entered this contest. It's a pity we don't have the space to print more of the ingenious, humorous and interesting replies entrants sent in.

New zinc diecast optical fibre connector

Rifa, distributors of the Amphenol range of connectors, recently released details of Amphenol's zinc diecast optical fibre connector, which can be used in place of plastic counterparts.

Optical fibres in use today are either of quartz or plastic fibre. Quartz fibre is expensive, but displays excellent performance in long-distance optical fibre telecommunications. Plastic fibre costs much less and is ideal for short-distance transmission.

The newly-developed Amphenol zinc diecast connector is designed for use with plastic fibre, and since it is metal instead of the generally used plastic, the fibre elements can be hermetically sealed, eliminating RF and electromagnetic interference.

Evaluation kits including one receiver, one transmitter and two metres of cable are available from Rifa at $26.50.

For further information contact Rifa Pty Ltd, 202 Bell Street, Preston Vic. (03)480-1300.

Scopex LCD CRO, local agent

The Scopex liquid crystal display oscilloscope featured in News Digest in the July issue is available in Australia through local instrument manufacturer, BWD.

The Scopex 'Voyager' is a dual-trace, digital storage instrument having very low power consumption and weighing only 2.5 kg.

The display is a dye phase-change type with a 125 x 256 matrix giving an active area of 64 x 102 mm, larger than many portable oscilloscopes.

Enquiries to BWD Instruments Pty Ltd, Miles St, Mulgrave Vic. 3170. (03)561-2888.

Digital thermostats and thermometers

The Victorian-based Twite Instrument Company has developed a range of thermostats and thermometers featuring digital operation.

The Model F1000, for example, features thumbwheel switches for easy setting of both turn-on and turn-off temperatures in 0.1°C steps, alarms for under and over temperature using delayed action to avoid false triggering, and alarm outputs for remoting. A LED display shows temperature.

Sensor and all functions may be remoted over long distances using three-pair telephone cable and a power module, claimed to greatly reduce installation costs. The F1000 comes in a standard 430 mm (19") rack cabinet. In inside or outside mounting the sensor is supplied with the unit.

For more details on this and other units in the range, contact Twite Instrument Company, P.O. Box 176, Shepparton Vic. (058)25-2042.

Instruments for Electronic Agencies

Electronic Agencies now stock Trio CROs, and have available the full range of Trio products as well as B&K Precision Instruments.

The Trio range includes a portable 15 MHz CRO, a 100 MHz CRO, frequency counter, function generator, resistance generator, colour pattern generator, electronic voltmeters, probes, dc power supplies and an acoustic measuring system.

The B&K range includes analogue and digital multimeters, semiconductor testers, frequency counters, logic equipment, capacitance meters, valve testers, probes, etc.

For details contact Electronic Agencies at 115 Parramatta Rd, Concord NSW.

Ceramic humidity sensor

Macron Electronic Ltd has developed a new ceramic humidity sensor with an element made of porous oxide ceramic sinter at high temperatures.

The fine crystalline surface of the element is highly absorbent to water molecules, and its resistance varies exponentially to the relative humidity of the atmosphere.

The element is packaged in a plastic case with a plastic mesh filter window and lead termination.

Full details from Associated Controls, P.O. Box 21, Padstow NSW 2211.

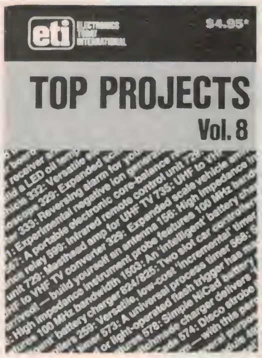
Joystick control units

Technico is now stocking joystick control units claimed to provide superior operation with quality construction, made by Flight Link Control Ltd of the UK.

The Model JS4 features a contactless inductive sensing system, a life claimed to be in excess of 10 million cycles, infinite resolution and zero noise, current drain of 15 mA on 10 V supply, centring consistency claimed to be better than ±1% of swing, short circuit proof outputs and 10 ms response time.

The JS1, 2 and 3 models are potentiometer types: the JS1 is a single-axis type, the JS2 a dual-axis type and the JS3 a triple-axis type. They feature all-metal construction, will accept most standard pots and wafer switches, spring or friction modes and a wide variety of levers and knobs.

Contact Technico for full details.



THE VERY LATEST

THIS GREAT NEW BOOK FROM ETI IS SO 'HOT OFF THE PRESS' THAT THE COVER LITERALLY GLOWS RED!

TOP PROJECTS VOL. 8

Our 'Top Projects' series have always been very popular with hobbyists, containing as they do a collection of the best projects from the past year or so's issues of ETI Magazine. Here we have 25 projects, ranging from the ETI-1501 Negative Ion Generator, to the ETI-499 General Purpose 150 W MOSFET Power Amp Module, from the ETI-574 Disco Strobe to the ETI-469 Percussion Synthesiser, from the ETI-735 UHF TV Converter to the ETI-563 NiCad Fast Charger.

Top Projects Vol. 8 is available at newsagents, selected electronic suppliers or directly, by mail order, from ETI Book Sales, 15 Boundary St, Rushcutters Bay NSW 2011, for $4.95 plus 90¢ post and handling.

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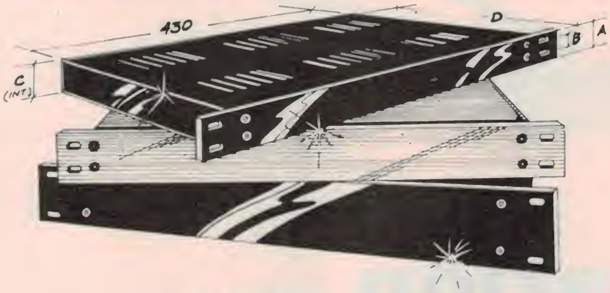

INTRODUCTORY PRICES

Cat No.	Finish	A	B	C	PRICE	5 or More
H 0401	Natural	44	34	38	$39.50	$38.00
H 0402	Natural	88	57	82	45.00	42.50
H 0403	Natural	132	89	126	49.50	45.00
H 0411	Black	44	34	38	39.50	38.00
H 0412	Black	88	57	82	45.00	42.50
H 0413	Black	132	89	126	49.50	45.00

Beware of other rack boxes that do not conform to international rack sizing.

DIODES, Small Signal

Z 0101	IN914/IN4148	.05
Z 0047	OA47	50
Z 0090	OA90 GER	.30
Z 0091	OA91 (Eqiv) GER	.20
Z 0095	OA95 GER	.25
Z 0096	OA202	.80
Z 0097	BA102 S1 Vari Cap	80
Z 0048	AA119 GER	40
Z 0100	HP5082 Hot Carrier	2.95

DIODES RECTIFIER

Z 0105	IN4002	100V 1A	.06	.05
Z 0109	IN4000	400V 1A	.08	.06
Z 0112	IN4007	1000V 1A	12	10
Z 0115	IN5404	400V 3A	35	28
Z 0118	IN5408	1000V 3A	.40	.34
Z 0120	R250A	400V 6A	.80	.70
Z 0125	BYX21L/200	200V/25A	2.95	2.80
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LEDS

		Ea.	10 Up	100 Up
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Z 0141	3mm Green	.20	.18	15
Z 0143	3mm Yellow	.22	.20	16
Z 0150	5mm Red	14	.10	.08
Z 0151	5mm Green	.20	.18	.15
Z 0152	5mm Yellow	.22	.20	.16
Z 1054	5mm Orange	.25	.22	19
Z 0160	Rect. Red	.22	.19	.18
Z 1062	Rect. Green	.25	.22	.20
Z 1064	Rect. Yellow	.25	.22	20

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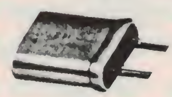

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Y 1000	1·000	5mm Pinout	11.50
Y 1003	1·8432	5mm Pinout	9.50
Y 1006	2·000	5mm Pinout	7.50
Y 1010	3·57945 Solder Type		3.00
Y 1012	4·000	12·3mm Pinout	5.00
Y 1015	4·194	12·3mm Pinout	5.00
Y 1017	5·000	12·3mm Pinout	5.00
Y 1018	6·000	12·3mm Pinout	5.00
Y 1019	8·000	12·3mm Pinout	5.00
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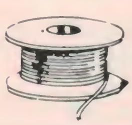

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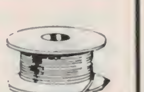

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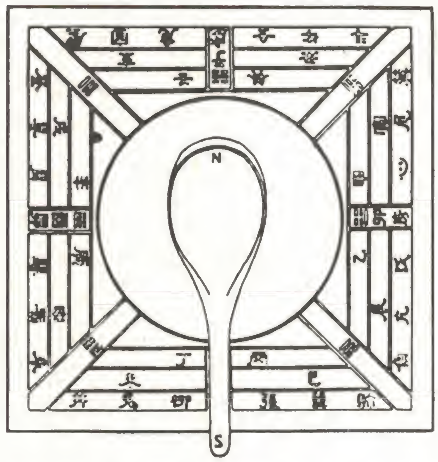
Inertial navigation systems

Christopher G. Heath



Primitive Chinese compass consisting of a magnetic spoon resting on a polished copper plate.

It took the human race over 900 years to progress from the primitive lodestone compass to a self-contained navigation system dubbed INS — the inertial navigation system. Here's a rundown on how it works.

THE EARTH'S rotation was discovered by Heraclides of Pontus in the 4th Century BC. During the next century, Erathosthenes of Cyrene calculated the circumference of the Earth to be approximately 38 500 km (24 000 miles), a figure undisputed for another 20 centuries.

Early writings suggest that the first lodestone compass was discovered by the Arabs or Chinese around 100 BC. The first reference to its use by Europeans is dated 1178. Also, the astrolabe was discovered about this period, the predecessor of the sextant, which was used to measure the angular elevation of stars and planets with respect to the horizon. This information was used in conjunction with elementary astronomical tables and time to plot a rudimentary navigational fix. Using this type of instrument, Columbus sailed to the New World.

The following inventions, together with Newton's Laws of gravitation, and Faraday's rules of electricity and magnetism, made INS a reality:

- an accurate marine chronometer (1766)
- the Foucault pendulum (1800)
- the marine gyro compass (1909).

The basics of INS

A basic inertial navigation system comprises the following subsystems:

- gyros
- accelerometers
- a computer.

A gyro is a device which, when spinning, points to a fixed position in space. To move the gyro from this position, pressure must be applied to the mounting frame (gimbals). If the gyro is moved up or down, it moves to the left or right. This action is called 'precession'.

An INS employs two gyro subsystems, one fitted in each horizontal plane or axis (X and Y). However, gyros are themselves subject to natural precession (errors) caused by the rotation of the earth (coriolis error) and the movement of the vehicle in which the gyro is fitted (attitude error). These errors are corrected by a servo or follow-up loop.

An accelerometer is an instrument which measures lateral movement and converts it to an electrical signal. To reduce errors in the accelerometers they are usually mounted to the gyro assembly. The electrical outputs from the instruments are converted to a suitable form and applied to the associated computer. Usually three accelerometers are fitted in a system, one in each axis (X, Y and Z).

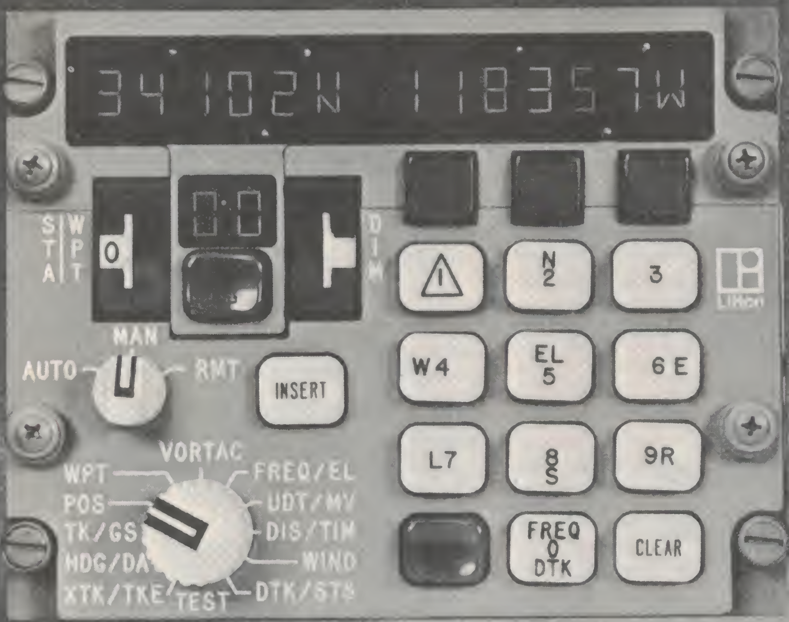
The computer associated with an INS provides the following functions:

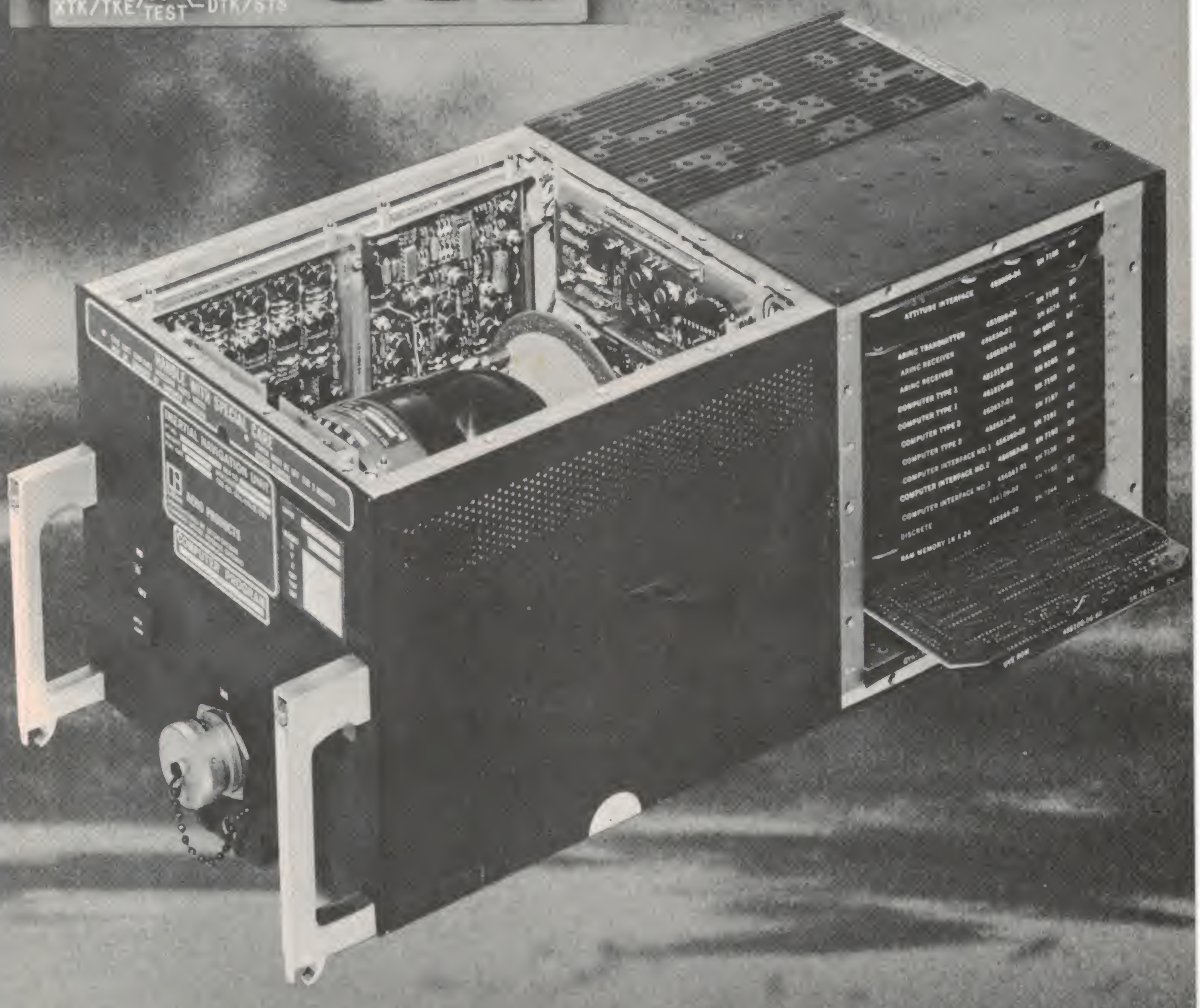
- coriolis correction
- latitude information
- attitude correction
- longitude information
- altitude or depth information
- distance travelled
- vehicle speed
- true or magnetic course data
- Earth's radius.

However, other systems are used in conjunction with INS to provide all the stated functions.

The computer runs an operational program automatically at system switch-on, or manually via the associated control unit. The program employs algorithms to solve various forms of mathematical equations, using detected variable and fixed quantities generated within the system or externally. These include distance travelled, vehicle acceleration, and the Earth's radius and rotational rate.

Although a self-contained system, its accuracy deteriorates with running time. This requires some form of external positional updating every 24 hours. ▶





A complete inertial navigation system, from Litton Aero Products. The large box contains the gimbal and inertial platform, plus servo and computer electronics, etc. At top left is the control display unit used to enter present position and waypoint co-ordinates, select track steering and display navigation data generated by the system. At top right is the mode selector unit.

usually helium or hydrogen. This reduces wear to nil while the gyro is rotating, and provides an unlimited life expectancy, determined by the number of system stop-start cycles.

The gyro float elements provide support for the spin bearings, gyro wheel, torque elements, and pickoffs, as well as forming a sealed enclosure around the rotating components. Floatation comprises suspension of the gyro sensing elements in liquid, in a similar manner to the slug of an accelerometer. However, gimballed (two-axis stabilised) rotor assemblies do not require floatation and are called 'dry gyros'.

The signal pickoff units monitor the angular displacement of the rotating components with respect to the gyro case and produce an electrical output proportional to this displacement. The pickoff elements are either inductive or capacitive devices which are highly sensitive electrical transducers, excited by an ac supply. Their characteristics ensure that they produce negligible heat and are capable of resolving the smallest increments of motion inherent in a gyro system.

The torque elements, which reposition the gyro assembly, are either synchro devices or dc force motors. These elements are manufactured to precision tolerances as they are required to produce high, variable precession velocities associated with components of Earth-rate varying with latitude.

The lead-in wires or ribbons connect the ac supply to the gyro motor, provide a signal path for the pickoffs, and apply input signals to the torquing elements. Mechanical errors produced by the lead-in wires are reduced by design.

Magnetic shields, which are made of steel alloys, are placed around the gyro assembly to reduce the effects of stray magnetic fields. These fields could produce unwanted torque on the moving parts.

The case provides a protective, gastight enclosure for the gyro assembly, and acts as a frame for the moving parts. The inside of the case is fitted with sensors which indicate the presence of moisture, high temperatures and excessive pressure.

Types of Gyro

There are two main types of gyro used for INS applications, the single-degree-of-freedom (SDF) type and the two-degree-of-freedom (TDF) type. The TDF gyro can be either a floatation or a gimballed device; Figure 8 shows the latter.

The gimballed TDF gyro can accept two different input torques, 90° apart. The input axis for one torque (IA_1) is also the output for one pickoff (OA_2); the converse (IA_2 and OA_1) is also true. Therefore two TDF gyros provide four sensing axes, three (X, Y and Z) of which can be controlled by two gyros. The redundant axis is caged or pegged in a closed loop servo condition.

By driving the rotor at the natural frequency of the support gimbals (tuned rotor) a rugged, unfloated gyro system is produced which has the following advantages over other gyro systems:

- reduction in components by 50%
- simplification of test and calibration procedures
- reduced manufacturing and repair costs
- improvement in reliability and mechanical performance
- increased system accuracy
- considerable reduction in size and weight.

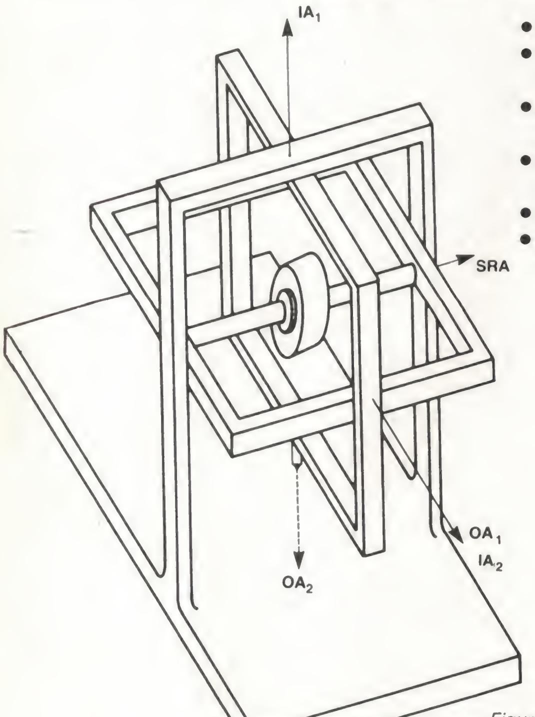


Figure 8. **A gimballed two-degrees-of-freedom (TDF) gyro.**

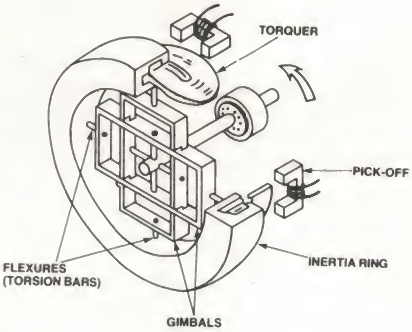


Figure 9. **A 'tuned rotor' operational gyro.**

An operational gyro of the tuned rotor type is shown in Figure 9. The rotor, which consists of a ring magnet encased in a soft iron return path fitted with a circumferential slot, is driven by a 400 Hz supply. The torquer (torque elements) comprises four coils, wound on a cylindrical former attached to the case. The coils in turn fit into a slot in the inertial ring where they can influence its magnetic field. The pickoffs are also magnetic devices consisting of differential transformers, which are influenced by the flux in the inertial ring. This method of pickoff can detect angular displacements in the order of 0.1 seconds of arc. To reduce non-magnetic, unwanted torques, the gyro operates in a low pressure hydrogen atmosphere.

Platform stabilisation

The gyros, accelerometers and associated equipment are known as the 'inertial platform' or 'platform' to distinguish them from the electronic, electrical and fixed components which form the rest of an INS installation.

The rotating gyro assembly possesses angular stability; the accelerometers do not, and therefore must be stabilised. This is achieved by mounting the gyros and accelerometers to a common platform. As the gyro case is attached to the same assembly as the accelerometers, their angular movement reflects the displacement between the gyro case and the rotor. These changes in movement are detected and held to a tolerable level, which in turn stabilises the platform. The application of this technique is detailed in Figure 10; however, the circuit shown is for one axis (X) only.

As the signal detected by the pickoff varies, the demodulator provides a drive signal of the opposite polarity to the platform drive motor, which adjusts the platform attitude accordingly. Overcorrection is prevented by secondary servo loops.

Stabilisation in three axes (X, Y and Z) requires two gyros and three accelerometers, one in each axis. However, the Z-axis is generally used to generate

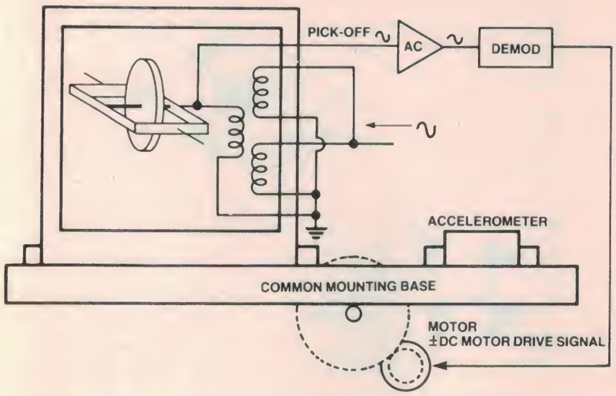


Figure 10. **Gyro-to-platform stabilisation loop, general arrangement.**

platform correction terms and in airborne systems to provide altitude information, whereas the X and Y axes are used to generate navigational information.

Platform corrections

When used for terrestrial navigation, an INS is subject to two major forms of error, coriolis error and centripetal error. Coriolis error is due to the rotation of the Earth, which acts upon the gyros, and centripetal error is brought about when the platform moves over the surface of the Earth between poles.

Compensation for coriolis error is achieved by the application of the Earth's rotation rate (approximately 15 degrees of arc per hour at the equator) to the platform. However, the rate varies with respect to latitude angle and is produced from a resolution of vectors, as shown in Figure 11. These vectors are calculated from the following equation:

Horizontal vector $= \Omega \cos \varnothing$
Vertical vector $= \Omega \sin \varnothing$

where omega Ω is full Earth rate (15 degrees) and phi $\varnothing$ is latitude angle.

Centripetal correction is only applied to the horizontal (X and Y) axes of the platform, as the vertical (Z) axis is insensitive to centripetal accelerations.

If the platform is held tangental to the curvature of the Earth, moves at a constant velocity, shares the Earth's centre of gravity, and moves over a great circle path (one whose axis passes through the centre of the earth), then the X and Y axes will sense the path of travel as a straight line and not require centripetal correction. However, any other path requires correction, which takes the form of a constant southward acceleration applied to the X and Y axis accelerometers. This correction is required, as the system, which is north-seeking, possesses an inherent northward drift when moving. The net result of the drift and correction is a zero velocity component applied to the accelerometers. The correction is generated within the system computer.

A servo system in conjunction with the system computer simulates the effect of the platform sharing the Earth's centre of gravity. This is called the Schuler pendulum effect, after the scientist who demonstrated the effect of Earth rotation.

To allow for radial accelerations in the Z-axis, the accelerometer is corrected for ground velocity over a curved surface given by the following equation:

$$\text{radial acceleration} = \frac{\text{velocity}^2 \text{ x gravity}}{\text{Earth's radius}}$$

The necessary functions are generated within the system computer.

System alignment

The operation of an inertial navigation system uses the mathematical integration of acceleration to obtain velocity and positional information. To implement any integration process, an accurate initial reference must be established, in this case velocity and position. The establishment of these references is called system alignment.

The alignment procedures entail the matching of platform and computer axes to external or internal known references. External references can be terrestrial, celestial or inertial. Terrestrial reference systems employ surveyed lines, benchmarks, plumb-bobs and bubble gauges. These devices can provide level accuracies in the order of ten seconds of arc and heading accuracies to three minutes of arc.

Celestial reference systems obtain information from star trackers and radio sextants. Accuracies are similar to those for terrestrial devices.

Inertial references comprise some form of portable inertial platform. However, accuracies are only as good as the last equipment calibration, which could have been months previous to their use.

An external reference system uses some form of interface unit to connect to the INS under test. These interfaces take the form of optical couplers, synchro devices, electrical transducers, digital-to-analogue or analogue-to-digital converters, or some form of logic conversion circuit.

Internal or self-alignment systems use the sensors on the platform to sense the physical deviation from a fixed position to align the platform using its servo systems.

To determine the orientation of a three-axis, right-angled co-ordinate system (INS), at least two reference vectors are required. The Earth's spin and gravitational vectors are used for this purpose when implementating a self-alignment procedure. Using these vectors reduces computer requirements because the accelerometer outputs do not require resolution into gravity and vehicle acceleration components. Also, as the accelerometers and gyros share the same platform, their relative positions do not require computing.

A self-alignment is divided into three inter-related modes. The first is coarse alignment, or caging, followed by fine alignment, or levelling, culminating in an operation called gyro-compassing.

Coarse alignment involves slaving the gyro gimbals to their own servo output signals, or to some external source ▶

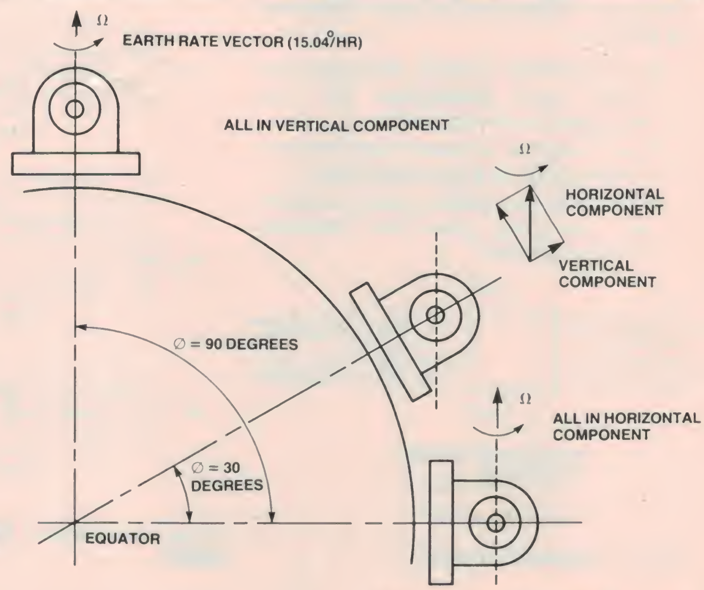


Figure 11. **Resolution of vectors in coriolis correction.**

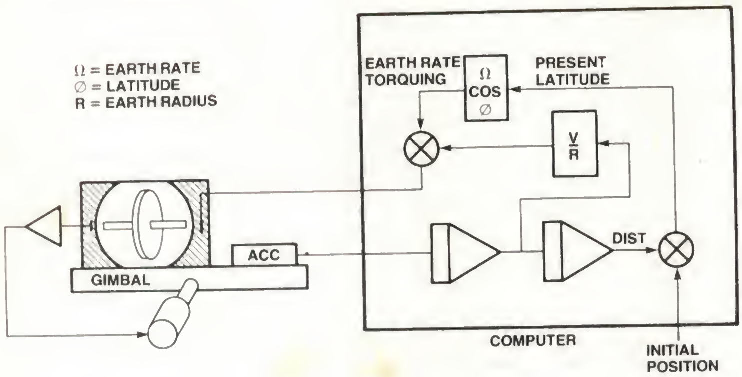


Figure 1. **Basic INS diagram.**

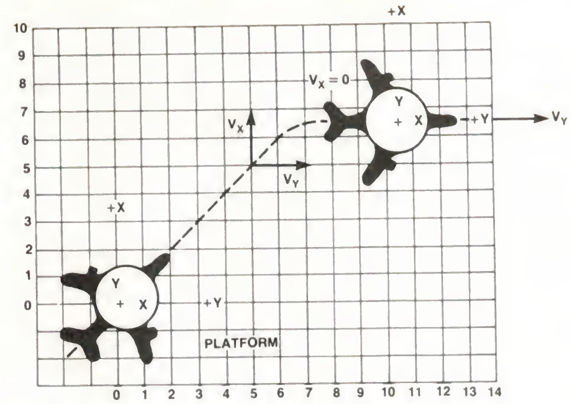


Figure 2. **Two-axis navigation grid.**

Radio navigation aids are normally used for this purpose. These include Omega, Decca, LORAN and distance measuring equipment (DME).

A basic inertial navigation system is shown in Figure 1 and operates as follows.

The accelerometer output (1) is integrated to a velocity function (2). A second integral produces distance travelled (3). This is added to initial position (4) and updates the present latitude (7). Present latitude is processed to provide Earth-rate torque (8). The velocity function (5) is processed to give transport torque rate (6). This and Earth-rate torque are added to generate gyro correction (9). This quantity causes the gyro rotor (10) to tilt with respect to the case and generate an output signal (11), which in turn is amplified to drive the gimbal motor (12). The gimbal motor moves the gimbal (13) in proportion to the Earth-rate and transport-rate terms, providing platform corrections.

Inertial navigation systems are fitted to military and commercial aircraft, surface ships of all types, submarines, hovercraft and space vehicles. To cater for this variety of system applications, the basic differences between types are as follows:

- a shipborne system requires precision gyro assemblies but less accurate accelerometers.
- an airborne system requires precision gyros and accelerometers.
- a missile-installed system requires less accurate gyros but precision accelerometers.

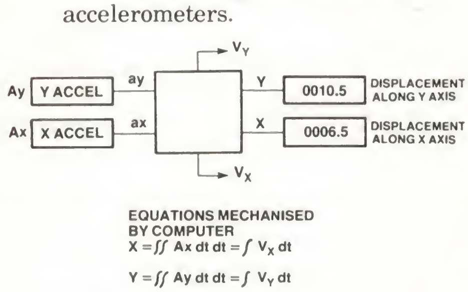


Figure 3. **Simple INS computer.**

System description

An inertial navigation system can be divided into the following sections for the purposes of description:

- simplified INS operation
- accelerometers
- gyros
- types of gyro
- platform stabilisation
- platform corrections
- system alignment
- system computer.

Simplified INS operation

The objective of all forms of navigation is to guide a vehicle from one point to another, relative to a reference system. Figure 2 shows a grid reference system upon which the course of an aircraft has been placed, and provides vector representation of the movement of the X and Y-axis accelerometers.

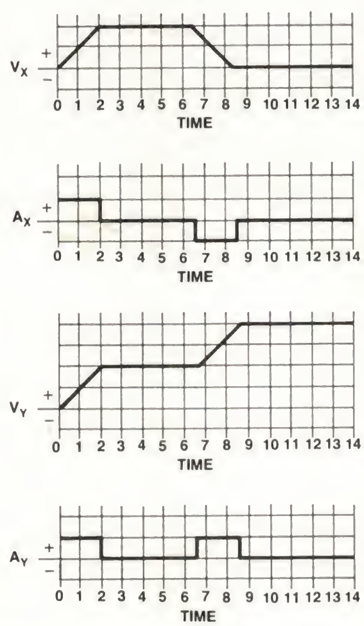


Figure 4. **Acceleration input and displacement output.**

Figure 3 illustrates a simple form of computer capable of resolving equations relating to vehicle displacement. Figure 4 presents a graphical indication of acceleration input and displacement output.

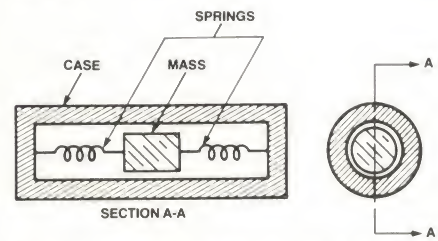


Figure 5. **General arrangement of a slug-type accelerometer.**

Accelerometers

A basic accelerometer, shown in Figure 5, comprises a precision-machine slug, or 'proof mass', which slides in a frictionless tube when lateral movement is detected. The slug is retained in the 'null' or zero position by springs. The magnitude of slug movement is a measure of acceleration, which is converted to an electrical signal by a 'pickoff unit'.

An alternative type of accelerometer, which operates on the pendulum principle, is detailed in Figure 6. This device provides displacement data in angular rather than linear form.

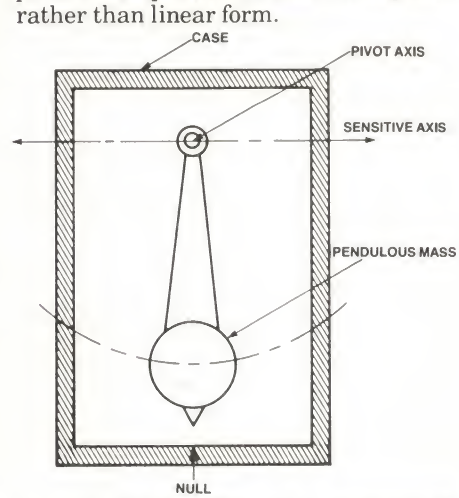
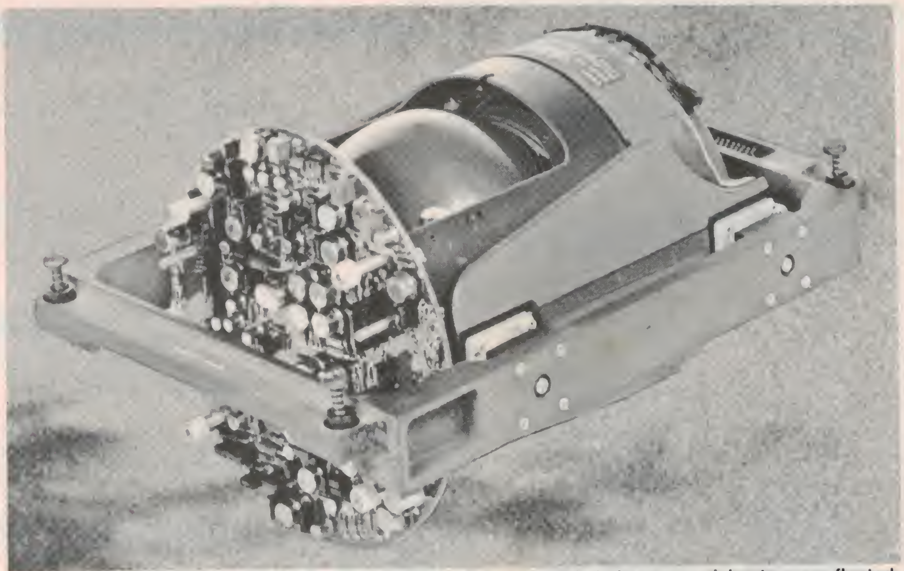


Figure 6. **General details of a pendulum-type accelerometer.**



A gimbal system, from Litton. This unit contains a cantilevered gimbal set comprising two non-floated, two-axis, precession-tuned rotor gyroscopes and three flexure-supported, non-floated, torque-to-balance accelerometers.

The relative movement of the mass in most accelerometers is restrained and therefore small, so small that it can only be detected by electrical measurement (via the pickoff). The pickoffs comprise a pair of primary coils, mounted to the instrument case. A secondary coil, attached to the mass, sits between the primary coils in the null position.

An excitation supply, applied to the primary and secondary coils, is arranged to provide zero output at the null. Under acceleration, the secondary coil moves towards one or the other primary coils and changes the phase and voltage output. The phase relationship between primary and secondary coils determines the sense of the acceleration (plus or minus) while the amplitude is proportional to acceleration magnitude.

In a typical application, the accelerometer output is amplified and used to drive a phase sensitive demodulator. The dc output signal is used to reset the mass to null, while generating a sense and magnitude input signal to the system computer.

This action is called torque rebalancing, which instead of measuring mass displacement, measures the current required to return the mass to the null position. A torque rebalancing arrangement is shown in Figure 7.

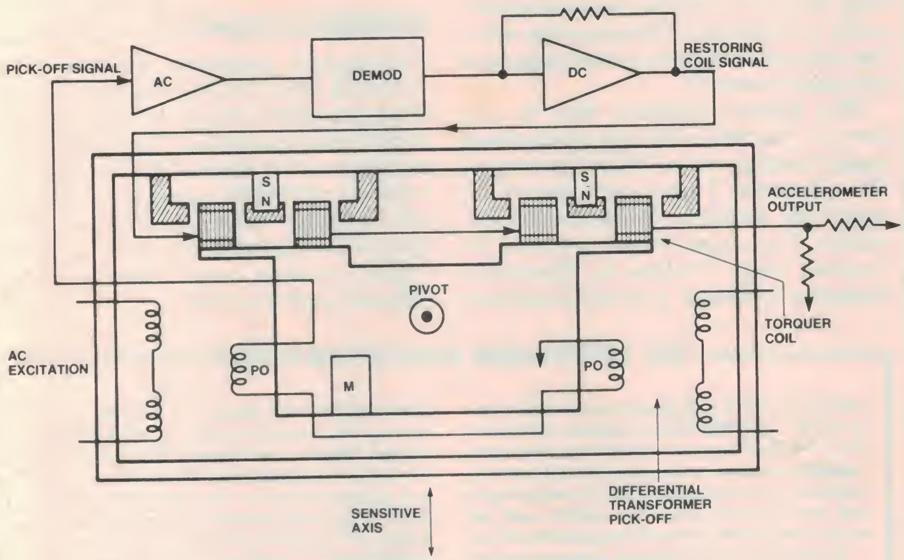


Figure 7. **Schematic arrangement of a torque rebalancing servo.**

Both types of accelerometer exhibit natural oscillatory characteristics, which are neutralised by immersion in damping fluid, carefully matched to the density of the mass to achieve neutral buoyancy. Other mechanical components reduce vibration and component instability to provide accuracies down to 10^{-6}g.

The latest types of accelerometer employ ceramic discs and capacitive pickoffs incorporated in a bridge circuit to detect acceleration displacement, the amount of electrical imbalance indicating the magnitude of the sensed acceleration. This signal is then used to operate a coil, called a force motor, to reset the ceramic discs. The reset current required by the force motor, or 'torquer', provides a computer input in a similar manner to the inductive type of accelerometer. However, the capacitive device uses fewer components and is much smaller.

Gyros

In 1750, a Swiss mathematician called Euler studied the behaviour of spinning rotors and documented his findings. A century later, a Frenchman, Foucault, constructed a device to demonstrate the Earth's rotation. He called it a gyroscope, from two Greek words — gyros (to turn) and skopios (to see or view). A German, Dr. Kaempfe, produced the first marine gyro compass, followed three years later by Elmer Sperry, who set the standard for gyro compass design until the introduction of INS in the 1950s. A modern gyro contains the following items:

- wheel assembly
- gyro motor
- spin bearings
- float elements
- signal pickoffs
- torque elements
- lead-in wires
- magnetic shields
- case.

The majority of the angular momentum of a spinning gyro is provided by the wheel assembly, which is a compromise of design factors. These include weight, rotation speed, diameter and construction material. Gyro wheels are usually manufactured of beryllium, to take advantage of its mechanical stability. However, titanium and stainless steel are used for some applications.

A gyro wheel is driven by a polyphase synchronous hysteresis motor, which is excited by a high frequency supply in order to achieve the required operating speed. The relative inefficiency of the motor is overcome by saturating the rotor to produce a virtual permanent magnet motor. However, the hysteresis motor has the ability to maintain, at synchronous speed, any load that it can accelerate from a dead stop.

The spin bearings are either long-life conventional ball bearing assemblies or gas-lubricated bearings. The latter eliminate metal-to-metal contact between surfaces once the device is operating. To achieve this state, the bearings run in a bath of gaseous lubricant, ▶

Inertial navigation systems

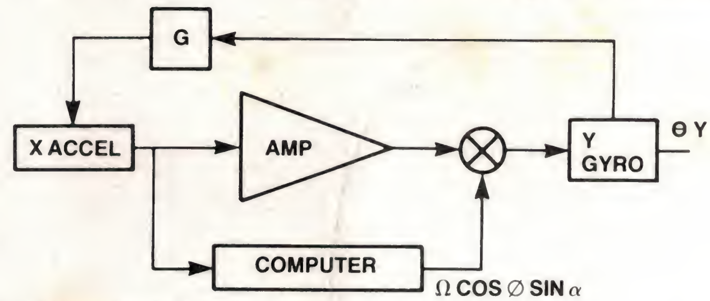


Figure 12. **System alignment servo loops.**

possessing a particular orientation with respect to the vehicle in which the platform is fitted. The caging sequence is automatically implementated by a timing circuit and lasts for about 30 seconds after system switch-on.

Fine alignment, together with gyro-compassing circuit configuration, is shown in Figure 12. The top feedback loop identifies levelling. This involves setting the pendulums of each accelerometer to the null position, each pendulum at 90° with respect to the other two. This is implemented by connecting the X-axis accelerometer output, via a function generator (G), to the Y-axis gyro and vice-versa. When the errors between the X and Y axes are zero, the Z or gravity axis is automatically in alignment. This provides one of the unknown vectors; gyro-compassing provides the other.

The bottom feedback loop in Figure 12 identifies the gyro-compassing circuit configuration. If left uncorrected, the platform Y-axis gyro would tilt under the influence of the Earth's spin vector. The angle of tilt is called the 'wander angle' or alpha (α). The system computer produces a set of acceleration corrections to the Y-axis gyro for a range of values for alpha, using a modification of the coriolis correction information detailed in Figure 11. The acceleration correction is given by the following equation:

$$\text{acceleration correction} = \cos\varnothing \sin\alpha$$

When the output of the X-axis accelerometer is zero, the platform has been aligned in the present position and no further system alignment is required. The Y-axis gyro and X-axis accelerometer are then connected in their normal operational configurations (X-axis accelerometer with X-axis gyro).

System computer

The system computer consists of a standard type of digital computer using microprocessor chips for control and computation purposes. The majority of program and mathematical information is held in EPROM memories. Access to the computer control circuits is via an operator-orientated keyboard. A set of digital readout units provides navigational and other data. ●

'MR. SUPER-CLEAN' KEEPS GYROS PRECISE

One place where navigational systems are made is in the Autonetics Marine Systems Division of Rockwell International in California. Rockwell's navigational systems are used in US Navy submarines, and most function so accurately that a sub can run submerged for months and still surface within a few metres of designated locations.

For this kind of performance, precision requirements of the gyros are immense. The heart of the gyros is a rotor consisting of a ball which must be perfectly round to within four millionths of an inch — that's about the width of a sliver of human hair split lengthwise into a thousand pieces. The ball spins in a cavity whose sides it clears by one-eighth of a human hair, which means that a microscopic particle can destroy its accuracy.

According to Bill Hanebaum, division manager of advanced manufacturing technology at Rockwell, "Human cleaning, regardless of the technician's dedication and the completeness of the engineered manual procedure, had proved to be an inconsistent operation in the production of our precision navigational gyros."

The gyros have to be cleaned in a chamber filled with filtered, pressurised nitrogen — an atmosphere in which humans can work only with oxygen masks, which bring contaminants with them. Human operators also need to wear surgical gloves to handle the pressurised, filtered liquid Freon used to wash the gyro ball and its cavity, and particles slough off these, causing contamination, regardless of the quality of the gloves.

Bill Hanebaum's answer to these difficulties was the invention of 'Mr. Super-Clean', a robot specially designed by another Rockwell division to meet the super-accurate needs of gyro production. The robot needs no oxygen mask or gloves, and its arm can move vertically and horizontally, can extend, rotate, and open and close its grippers. All movements are controlled to within thousandths of an inch, and the robot can remove particles invisible to the human eye which could nevertheless affect the accuracy of the gyro.

An AIM 65 microcomputer, manufactured by another Rockwell organisation, controls the robot, providing a control system for under $1000 while still meeting designers' specifications.

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ZE1540	5082-2800	3.35	
ZE1545	OA47	0.45	
ZE1550	10A/400V Diode Stud	2.50	2.40
ZE1555	BYX21L/200	2.50	2.40
ZE1557	BYX21L/200R	2.50	2.40
ZE1560	Bridge 400V/1.5A	0.90	0.80
ZE1565	Bridge 400V 40A	4.50	4.20
ZE1650	Zener Diode 2.7V	0.35	0.30
ZE1653	Zener Diode 3V3	0.35	0.30
ZE1655	Zener Diode 3V6	0.35	0.30
ZE1657	Zener Diode 3V9	0.35	0.30
ZE1659	Zener Diode 4V3	0.35	0.30
ZE1661	Zener 1N4732 4V7	0.35	0.30
ZE1663	Zener 1N4733 5V1	0.35	0.30
ZE1665	Zener 1N4734 5V6	0.35	0.30
ZE1667	Zener 1N4735 6V2	0.35	0.30
ZE1669	Zener 1N4736 6V8	0.35	0.30
ZE1671	Zener 1N4737 7V5	0.35	0.30
ZE1673	Zener 1N4738 8V2	0.35	0.30
ZE1675	Zener 1N4739 9V1	0.35	0.30
ZE1677	Zener 1N4740 10V	0.35	0.30
ZE1679	Zener 1N4741 11V	0.35	0.30
ZE1681	Zener 1N4742 12V	0.35	0.30
ZE1683	Zener 1N4743 13V	0.35	0.30
ZE1685	Zener 1N4744 15V	0.35	0.30
ZE1687	Zener 1N4745 16V	0.35	0.30
ZE1689	Zener 1N4746 18V	0.35	0.30
ZE1691	Zener 1N4747 20V	0.35	0.30
ZE1693	Zener 1N4748 22V	0.35	0.30
ZE1695	Zener 1N4749 24V	0.35	0.30
ZE1697	Zener 1N4750 27V	0.35	0.30
ZE1699	Zener 1N4751 30V	0.35	0.30
ZE1701	Zener 1N4752 33V	0.35	0.30
ZE1706	Zener Diode 62V	1.20	1.00
ZE1715	Zener Diode 75V	1.20	1.00
ZE1801	Led Flashing Red	0.50	0.45
ZE1811	Led Small Red 3 mm	0.20	0.15
ZE1819	Led Small Green 3 mm	0.20	0.15
ZE1821	Led Yellow 3 mm	0.20	0.15
ZE1832	Led Red 5 mm	0.15	0.09
ZE1836	Led Green 5 mm	0.30	0.25
ZE1840	Led Yellow 5 mm	0.30	0.25
ZE1844	Led Orange 5 mm	0.30	0.25
ZE1846	Led Clear/Red 5 mm	0.55	0.50
ZE1850	Led Rectangular Red	0.30	0.25
ZE1854	Led Rectangular Green	0.30	0.25
ZE1856	Led Rectangular Yellow	0.30	0.25
ZE1860	Led Rectangular Red Bright	0.20	
ZE1861	Led Rectangular Red Normal	0.15	
ZE1862	Led Rectangular Yellow	0.15	
ZE1880	LT303 Display	1.60	1.40
ZE1883	DL704 Led Display	3.35	3.00
ZE1886	DL707 (LT302)	1.90	1.75
ZE1889	DL747	4.70	
ZE1891	FND500 Display	1.20	1.10
ZE1892	FND507 Display	1.95	1.80
ZE1899	LAD203/7106	39.95	
ZE1930	SCR C103B	1.38	
ZE1940	SCR C106Y1	0.70	
ZE1950	SCR C106D1	1.00	0.90
ZE1960	SCR C122D	1.80	
ZE1970	SCR C122E	1.80	
ZE1980	SCR C164D	4.95	
ZE1983	SCR C168D	8.50	
ZE1991	TRIAC SC141D	1.40	1.30
ZE1993	TRIAC SC146D	2.00	
ZE1997	TRIAC SC151D	2.95	2.75
ZE1999	ST4 Diac	0.75	
ZE2005	ORP12	2.50	
ZE2010	4N28/4N25	1.20	
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ZE2101	74LS01	0.35	0.30
ZE2102	74LS02	0.35	0.30
ZE2104	74LS04	0.35	0.30
ZE2108	74LS08	0.35	0.30
ZE2110	74LS10	0.35	0.30
ZE2114	74LS14	0.85	
ZE2120	74LS20	0.35	0.30
ZE2130	74LS30	0.40	0.35
ZE2173	74LS73	0.65	0.60
ZE2174	74LS74	0.55	0.50
ZE2176	74LS76	0.65	0.60
ZE2185	74LS85	1.70	1.60
ZE2186	74LS86	0.60	0.55
ZE2190	74LS90	1.00	0.90
ZE2192	74LS92	0.95	0.85
ZE2193	74LS93	0.95	0.85
ZE2195	74LS95	1.00	
ZE2197	74LS123	1.00	0.90
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ZE2300	7400	0.40	0.35
ZE2301	7401	0.35	0.30
ZE2302	7402	0.35	0.30
ZE2304	7404	0.45	0.40
ZE2305	7405	0.55	0.50
ZE2308	7408	0.40	0.35
ZE2310	7410	0.40	0.35
ZE2313	7413	0.75	
ZE2314	7414	0.90	0.80
ZE2320	7420	0.30	0.27
ZE2330	7430	0.40	0.35
ZE2337	7437	0.50	
ZE2341	7441	1.36	
ZE2347	7447	1.40	1.30
ZE2353	7453	0.35	0.30
ZE2354	7454	0.40	0.35
ZE2370	7470	0.45	0.40
ZE2373	7473	0.75	0.70
ZE2374	7474	0.65	0.60
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ZE2421	74121	0.75	0.70
ZE2423	74123	0.85	0.80
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ZE2492	74192	1.20	1.10
ZE2493	74193	1.20	1.10
ZE2496	74196	2.35	2.10
ZE2600	74C00	0.40	0.35
ZE2602	74C02	0.34	
ZE2614	74C14	1.50	1.40
ZE2630	74C30	0.65	0.60
ZE2922	74C922	7.20	6.90
ZE2926	74C926	8.75	
ZE4000	40000	0.50	0.40
ZE4001	4001	0.35	0.32
ZE4002	4002	0.60	0.50
ZE4007	4007	0.35	0.30
ZE4009	4009	0.75	
ZE4011	4011	0.35	0.30
ZE4012	4012	0.40	
ZE4013	4013	0.75	0.70
ZE4015	4015	2.20	1.05
ZE4016	4016	0.65	0.60
ZE4017	4017	0.95	0.90
ZE4018	4018	1.40	1.20
ZE4019	4019	1.00	0.90
ZE4020	4020	1.40	1.30
ZE4022	4022	1.48	1.00
ZE4023	4023	0.40	0.35
ZE4024	4024	0.90	0.85
ZE4025	4025	0.35	0.32
ZE4026	4026	2.95	
ZE4027	4027	0.80	0.75
ZE4028	4028	1.20	
ZE4029	4029	1.65	1.45
ZE4030	4030	0.90	0.85
ZE4040	4040	1.50	1.40
ZE4046	4046	1.50	1.45
ZE4047	4047	2.50	1.00
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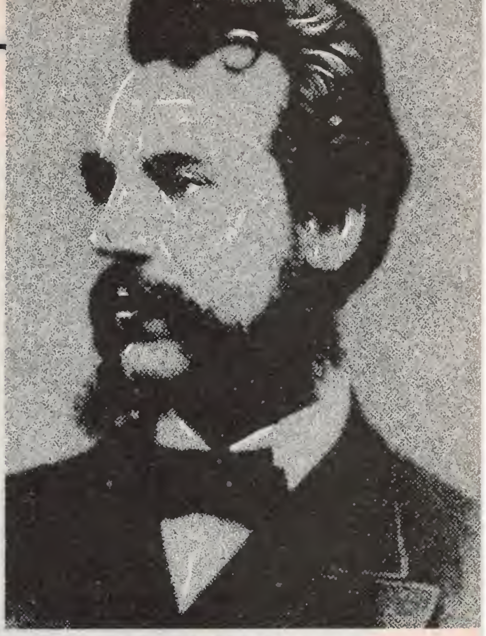
ZE4050	4050	0.75	0.68
ZE4051	4051	1.30	1.20
ZE4052	4052	1.90	1.70
ZE4066	4066	0.65	0.60
ZE4068	4068	0.50	0.40
ZE4069	4069	0.39	0.35
ZE4071	4071	0.35	0.32
ZE4081	4081	0.40	
ZE4082	4082	0.29	0.25
ZE4093	4093B	0.90	0.80
ZE4194	40194	3.50	3.00
ZE4503	4503	0.95	0.85
ZE4511	4511	1.35	1.25
ZE4518	4518	1.60	1.00
ZE4520	4520	1.40	1.30
ZE5020	MOC3020/1	2.50	2.30
ZE5071	TL071 (LM351N)	1.20	0.90
ZE5074	TL074	3.25	
ZE5080	CA3080	1.80	1.60
ZE5116	MC10116	1.70	1.60
ZE5130	CA3130	1.95	1.80
ZE5136	UA4136	1.80	1.70
ZE5140	CA3140	1.65	1.50
ZE5170	UAA170	4.50	
ZE5180	UAA180	4.85	
ZE5206	XR2206	6.50	6.00
ZE5301	LM301	0.60	
ZE5308	LM308	1.15	
ZE5311	LM311N	0.90	
ZE5319	LM319	3.95	
ZE5324	LM324	1.20	1.14
ZE5339	LM339	0.80	0.70
ZE5344	NE5534N	1.80	1.70
ZE5345	NE5534AN	2.70	2.55
ZE5350	OM350	10.95	
ZE5369	MM5369	4.25	4.00
ZE5379	LM380 (8DIL)	1.80	1.50
ZE5380	LM380 (14DIL)	1.65	1.45
ZE5381	LM381	3.50	3.25
ZE5382	LM382	2.90	2.70
ZE5387	LM387	0.84	
ZE5393	LM393	1.95	1.60
ZE5394	LM394	4.75	4.30
ZE5401	5401	2.50	2.20
ZE5416	IC 7216A	39.00	37.00
ZE5488	SN76488	5.25	5.00
ZE5499	2716/2516	5.00	4.75
ZE5500	2716/2516 Pre-Prog	17.50	
ZE5505	MM6821	4.50	4.25
ZE5510	CDP1802	11.50	11.00
ZE5515	CDP1822	11.50	10.75
ZE5520	CDP1864	13.00	12.00
ZE5554	7555	2.20	2.00
ZE5555	NE555	0.35	0.32
ZE5556	NE556	1.20	1.00
ZE5570	NE570N	4.35	
ZE5600	SAB0600	7.50	7.00
ZE5709	UA709 14 Pin	0.75	0.70
ZE5723	LM723 14 Pin	0.95	0.85
ZE5724	LM723 TO5	1.14	1.09
ZE5741	LM741 8 Pin	0.40	0.36
ZE5837	MM5837	5.25	
ZE5900	LM3900	1.00	0.95
ZE5909	LM3909	1.45	
ZE5911	LM3911	1.95	1.80
ZE5914	LM3914	4.75	
ZE5915	LM3915	4.50	
ZE5917	LM2917	3.75	
ZE5990	11C90	22.95	
ZE6005	7805/LM340T5	0.95	1.05
ZE6012	7812/LM340T12	0.95	0.85
ZE6015	7815/LM340T15	0.95	0.85
ZE6030	LM317T 2-30V Reg	2.30	2.00
ZE6032	LM317K 2-30V Reg	4.95	
ZE6050	LM337 V Reg TO3	6.50	
ZE6115	7905 LM320T5	1.50	1.30
ZE6122	7912/LM320T12	1.50	1.30
ZE6125	7915/LM320T15	1.50	1.30
ZE6200	LM340K5/LM309K	2.85	
ZE6205	78H05 5A 5V	11.90	
ZE6310	79L12	0.75	0.70
ZE6502	2102 Ram	2.60	2.50
ZE6514	2114 4K Ram	2.75	2.50
ZE6516	4116	2.95	


Bell, inventor of the photophone, pictured in 1876, the year he patented the telephone.

Build a 'photophone' light beam transceiver

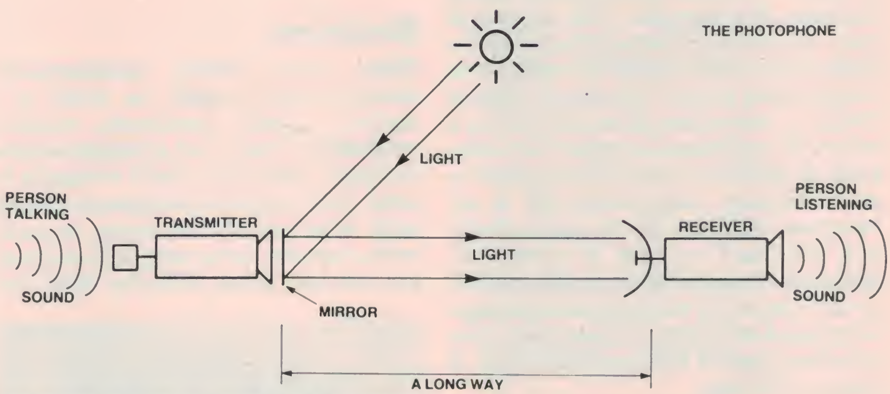
Unlike the telephone, the photophone is probably Alexander Graham Bell's most obscure invention. Instead of wires, you can talk on a beam of light. This modern — solid state! — version is simple to build and remarkably effective.

Phil Wait
William Fisher

A PHOTOPHONE is a device for sending voice signals along a light beam. The word 'photophone' dates from 1880, when Alexander Graham Bell coined it to describe his own light-beam communication system. At his death in 1922, Bell was still convinced that the photophone was his most important invention, more important even than the telephone, which by that time had spread into a worldwide network.

However, the world in general disagreed with Bell and went ahead with communication systems using wires or radio waves as carriers, in preference to light waves. (The development of fibre optics may reverse this trend, but that's another story.) The photophone was forgotten by everyone except a few historians of science.

In the interests of nostalgia and entertainment we have revived this ancient invention, using some modern electronics instead of the cumbersome and unreliable modulation and detection equipment that Bell was forced to use. (He was working in the pre-electronic age, nearly thirty years before triode valves were invented and seventy years before transistors.)



Illustrating the basic principle of the photophone.

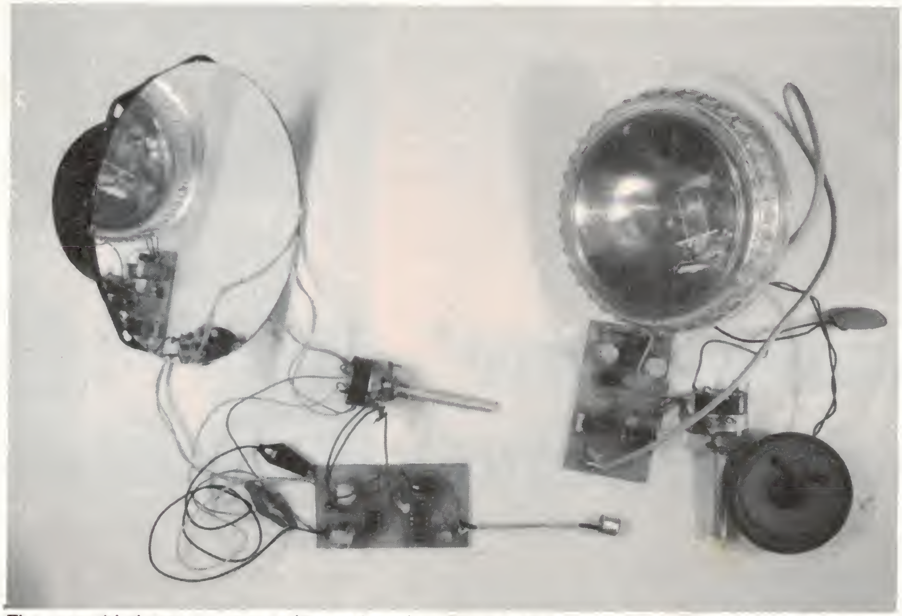
The principle

The basic principle of the photophone is that a normally flat mirror is made to flex slightly by sound waves impinging on it. A light beam is reflected off the mirror and aimed at a photosensitive receiver. As the mirror is flexed by the sound waves it becomes alternately convex and concave, which means that the beam reflected onto the receiver becomes alternately wider and narrower, in time with the sound wave. The total number of photons in the light beam is not altered by these changes in its width, but the fraction of that energy which falls on the receiving surface does vary (providing the beam is always wider than the receiver). So the intensity of the light received varies with the width of the light beam, which in turn varies with the curvature of the mirror, which is caused by the pattern of sound waves hitting it.

The variations in light intensity at the receiver can be converted into an electrical signal which drives a loudspeaker via an amplifier to reproduce the sounds originally produced at the transmitting end. The whole arrangement is a kind of amplitude modulation of the light beam, with the mirror acting as the modulator and the photosensitive surface acting as the demodulator.

Transmitters

The first problem is to make the mirror flex in time with the sound wave. Bell's original mechanism for doing this was very simple. He used a thin mirror ▶



The assembled prototype transmitter and receiver. The transmitter was powered by a 6 V lantern battery, the receiver by a 9 V transistor radio battery. We used a solar cell mounted in a lantern reflector, as described below.

firmly glued over the end of a flexible tube. When he spoke into the other end, sound waves travelled down the tube to make the mirror vibrate. This method is quite effective and you can use any kind of tube — a rigid cardboard or metal cylinder, for example. The mirror is more of a problem, because it needs to be quite thin to flex enough in response to unamplified voices. You may be able to obtain an ultra-thin glass mirror from a scientific equipment supplier, but some kind of reflective foil will be easier to get. Ordinary aluminium foil is an excellent reflector but it tears easily and it's hard to keep it uncreased, although these problems can be avoided to some extent by sticking adhesive tape to the back of the foil. Aluminised mylar (or other plastic) foil is probably best, if you can find any.

For our own transmitter we opted to use a circular glass mirror of normal thickness, such as you might buy in any chain store as a shaving mirror (the flat variety — not concave). We mounted this on the frame of a 150 mm diameter circular loudspeaker and made an amplifier to drive the speaker with sufficient power to flex the mirror. If you want to use this method, buy the speaker first, then look around for a shaving mirror the same diameter or slightly larger. Remove the metal or plastic rim and you will usually find two mirrors, one flat and one concave. Discard the concave mirror and glue the flat one to the metal rim (NOT the cone) of the speaker, using epoxy resin. Don't use a silicone compound like Silastic, because the joint must be rigid. The wider the speaker and mirror you use, the better the range and the lower the distortion, because a wider mirror can flex more. The amplifier and microphone are described under 'Electronics'.

Receivers

There are several photosensitive devices which might be used in a receiver. Light dependent resistors respond too slowly, but a phototransistor is much faster and could certainly be used. Bell's original photophone receiver used selenium photoresistors in series with a battery and a telephone earpiece, but he had great difficulty with this system. (Bell deserves credit for any success with this astonishingly crude arrangement. As Dr. Johnson remarked about a dog walking on its hind legs — it was not done well, but it is astonishing that it was done at all!)

Close up of our receiver input device. This consists of a small solar cell piece mounted in a reflector taken from a 'Dolphin' lantern. To mount the cell, we cut a slot in one side of the reflector, put Silastic on the rear of the solar cell (leads already attached) and inserted it in place. It proved very effective.

For our receiver we opted to use a 'solar cell', which is a kind of silicon photodiode. The large area and easy availability of solar cells make them the best choice overall. The effective area of the cell was made even larger by mounting it near the focus of a parabolic reflector taken from a hand lantern and an even larger effective area could be obtained by using a car headlamp reflector. Bell's original photophone used a reflector nearly a metre in diameter to gather the light, but anyone thinking of using very large reflectors should remember that the reflector must not be wider than the beam it is collecting, otherwise the modulation cannot be detected.

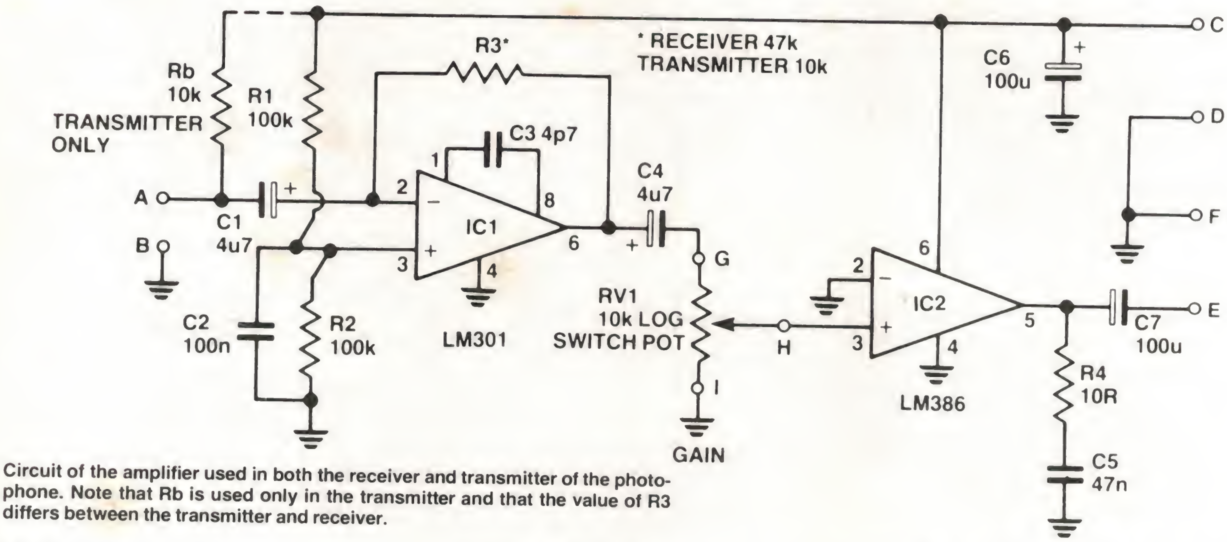
Light sources

In principle any light source will work. At night, with no other lights nearby, a pocket flashlight has been reported to work by some experimenters, but we haven't tried this ourselves. In daylight you need an intense and collimated (i.e: parallel) beam to get any reasonable range. A gas laser (such as a helium-neon type) is an ideal source, which in principle could give you a range of several kilometres in open country or over water, but some precautions are necessary. A low power laser is safest, preferably one having an output of one milliwatt. If possible, a 'beam expanding telescope' should be fitted to it. This increases the diameter of the beam making it easier to aim and reducing possible harmful effects to the eyes of any person who may accidentally look into the beam. The person setting up the receiver should not look toward the laser. Note that the beam at the receiver must be larger than the receiving device. This is where a beam expanding telescope helps.

This project makes a good 'science demonstration' project if your school science department has a suitable laser.

However, a much more readily-available light source is the Sun whose light output is quite intense and has reasonably parallel rays. Using reflected sunlight, we found that we could communicate intelligibly by photophone over distances of a few hundred metres. With more efficient transducers (ours were deliberately simple) this distance could probably be extended. ▶


MAX•550
logic probe
4001 PULSE GENERATOR
8001 FUNCTION
PRESCALER



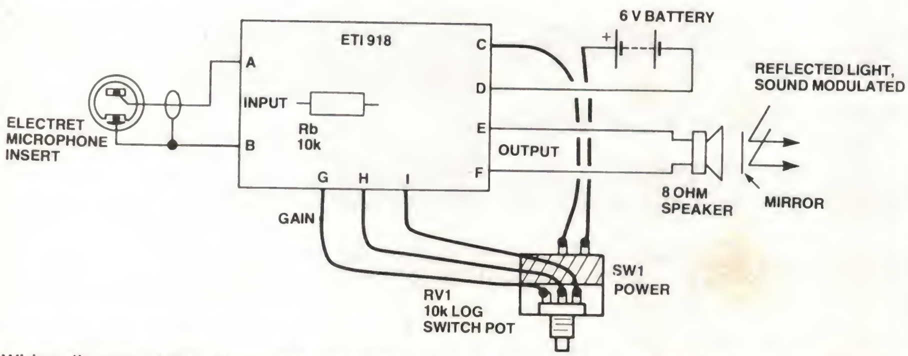
Circuit of the amplifier used in both the receiver and transmitter of the photophone. Note that Rb is used only in the transmitter and that the value of R3 differs between the transmitter and receiver.

Electronics

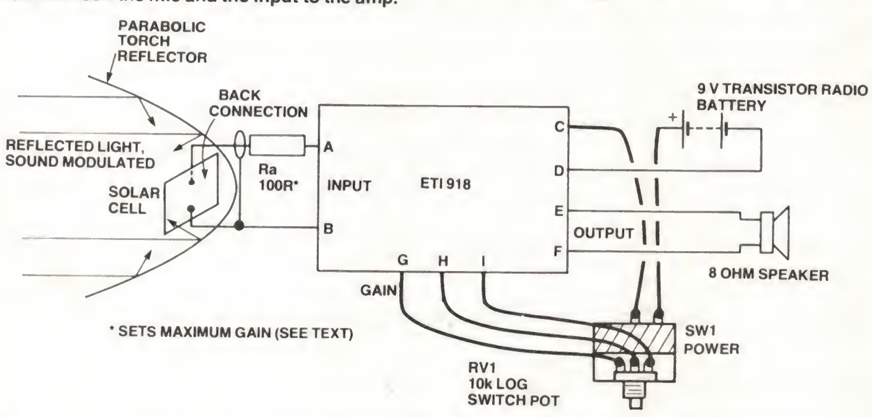
To amplify speech to drive the loudspeaker of the transmitter, we designed a simple amplifier around two ICs — an LM301 voltage amplifier and an LM386 power amplifier. There was no point in making a low noise, low distortion amplifier because the transmitting and receiving transducers are relatively noisy and non-linear. However, performance is quite acceptable. Speech signals from an electret microphone insert are amplified by the LM301, then attenuated by a gain-control potentiometer before being fed to the LM386, whose output drives the loudspeaker. The large speaker needs a lot of current to drive it, so a six volt lantern battery is the best kind of power supply.

The receiver uses a very similar amplifier to boost the tiny signal derived from the solar cell, the dc component of this signal being blocked by a capacitor.

The receiver amplifier is so similar to the transmitter amplifier that it uses the same pc board design. The only differences are that the feedback resistor (R3) around the LM301 op-amp has a larger value in the receiver to give



Wiring diagram of the photophone transmitter. Note the wiring to the rear of the electret microphone insert. You'll find one connection attaches to the mic case. This is the 'common' and goes to B on the pc board. Some inserts have leads already attached. Usually the common lead will be black. Use a shielded lead between the mic and the input to the amp.



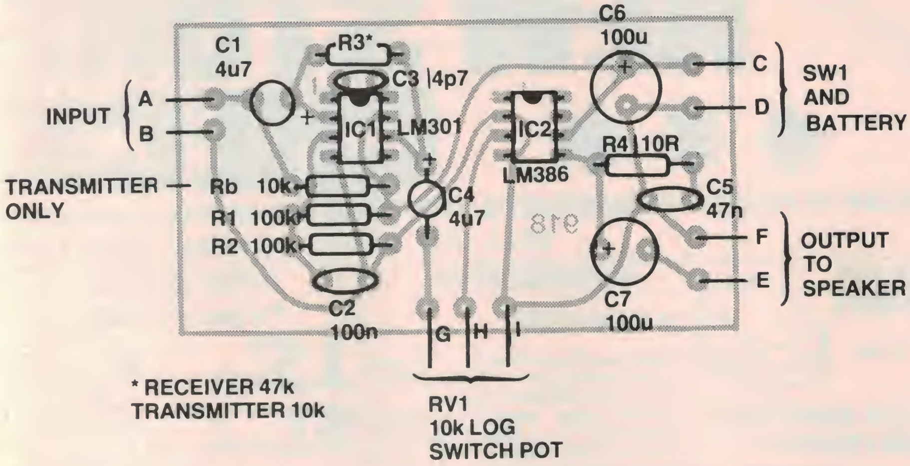
Photophone receiver wiring diagram. Use a shielded lead between the solar cell and the amplifier input. Don't forget to connect a 100 ohm resistor in series with the lead to terminal A on the amp.

HOW IT WORKS — ETI-918

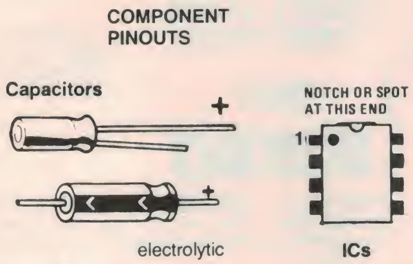
Sound received by an electret condenser microphone is amplified by the transmitter amplifier and used to drive a loudspeaker. A plane (i.e: flat) mirror attached to the housing of this loudspeaker is flexed by the sound wave emitted by the speaker, so that it becomes alternately convex and concave as the sound pressure increases and decreases. A beam of sunlight reflected by the mirror onto a solar cell at the receiving end becomes broader or narrower as the mirror flexes, in phase with the sound pressure variations. Providing the beam always completely covers the collecting surface, a broader beam means that fewer photons are collected by the solar cell and a narrower beam means that more photons are collected.

The variation in the number of photons collected causes a proportional variation in the current generated by the solar cell. These current variations cause variations in the voltage across resistor Ra, and these voltage variations are amplified by the receiver amplifier, which drives a small loudspeaker to reproduce the sounds spoken into the transmitter microphone.

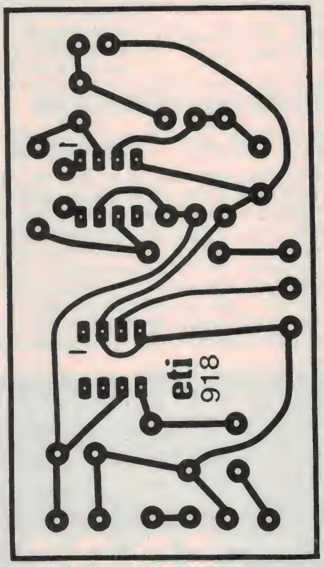
The transmitter and receiver amplifiers are essentially similar, each using an LM301 op-amp (IC1) for voltage multiplication and an LM386 power amplifier (IC2) with a switch potentiometer (RV1) between these two ICs for manual gain control. Resistor Rb (in the transmitter amplifier only) provides bias for the electret microphone. Capacitor C1 blocks dc signals. The gain of IC1 is set by the ratio of the resistance of R3 to the impedance of C1 at audio frequencies. The potential divider formed by R1 and R2 biases the non-inverting input of IC1 up to half the supply voltage, so that IC1 can be used with a single ended supply. C4 blocks any dc offset of IC1's output, R4 and C5 prevent instability around the output stage and C8 prevents any dc offset from being applied to the speaker. C4 and the internal resistance of the battery form a low-pass filter that removes battery noise from the supply line.



Component overlay for the amplifier. Note that Rb is not needed in the receiver amplifier and that the value of R3 differs between the transmitter and receiver.



See 'Shoparound' page in this issue for where to buy components



Printed circuit board artwork, full size.

higher gain, and the transmitter has an extra resistor (Rb) to bias the microphone. Only a small speaker is necessary for the receiver, so that a nine volt transistor radio battery can be used as power source.

Construction

We haven't designed any kind of box for this project. Obviously permanent housings for the transmitter and receiver will make the photophone much easier to use, but you can't make them until you've done some experimenting and finally decided what shape and size of reflectors you are going to use. In any case, this is a magazine about electronics, not carpentry or metalwork!

The two amplifiers should present no difficulties in assembly, providing you remember the usual precautions — check the orientation of capacitors, diodes and transistors, use a smallish bit when soldering the IC pins and let the ICs cool down for a few seconds between soldering each pin.

The electret microphone insert is polarised, so it can only go one way round. Make sure you solder the negative lead (usually black) to point B on the pc board and the positive lead (usually red) to point A. Glue the flat mirror to the metal rim of the transmitter loudspeaker (not to the cone), using epoxy resin (not any other adhesive).

Some solar cell pieces come with leads attached, some do not. If you have to attach your own leads, do it very carefully, using a low wattage iron and thin flexible wire. Most cells have electrodes on the front and back surfaces: solder to the back electrode first, by forming a small pool of solder near the edge of the cell and holding the end of the wire in the pool until it cools. The front electrode is usually in the form of a thin strip and needs more care. Apply enough solder to form a bump or ridge, reheat the solder and position the second wire. The leads must be protected from strain and can be glued to the reflector if one is used. Connection to the amplifier should be made through shielded cable. Don't forget to insert the 100 ohm resistor (Ra) in series with the lead that connects to point A on the pc board (see the overlay diagram). The solar cell can be held in position with plasticene while you are experimenting, or with silicone compound (such as Silastic) for a more permanent bond.

Operation

Leave the receiver with a friend and walk in the direction of your shadow, then point the transmitter so that the sun's reflection is directed at the receiver. It helps to put the receiver in the shade, so that you can see the spot of light from the transmitter mirror more easily.

You'll find that only a very small movement of the transmitter is enough to move the spot off the receiver, so it's easier if, once you've got the direction approximately right, you keep the transmitter steady on the ground or on a table and move the receiver to make the fine adjustments. Alternatively, you could keep the receiver fixed and mount the transmitter on a tripod.

A word of warning — don't point the light beam at your assistant's eyes (or anyone else's) if you're using the sun as the light source. To be safe, wear sunglasses (half-silvered types cut out most light) and never look directly at the mirror. ●

PARTS LIST — ETI-918

The following is a list of parts needed to build an electronically amplified transmitter and receiver to our specifications. The numbers in brackets represent the total number of components required of that value or type. If you are not using an amplifier in your transmitter, you will only need one of each component listed (i.e: one of R1, one of R2, etc.)

Resistors .... all ½ W, 5%
R1, R2 .... 100k (4)
R3 .... (2) see text
R4 .... 10R (2)
Ra 100R (1)
Rb 10k (2)

Potentiometers
RV1 .... 10k log. switch pot

Capacitors
C1, C4 .... 4u7/16 V RB electro. (4)
C2 .... 100n greencap (2)
C3 .... 4p7 ceramic (2)
C5 .... 47n greencap (2)
C7, C8 .... 100u/16 V RB electro. (4)

Semiconductors
IC1 .... 301 op-amp (2)
IC2 .... 386 power amp (2)

Miscellaneous
One or two ETI-918 pc boards, one electret microphone insert, small solar cell piece, parabolic torch reflector, small 8 ohm speaker, 150 mm 8 ohm speaker, 150 mm or larger diameter round mirror to match diameter of speaker, 6 V lantern battery, 9 V transistor radio battery, short length of shielded cable, insulated hookup wire.

Price estimate
$35 — $40 (complete) $22 — $25 (electronics only)

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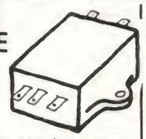

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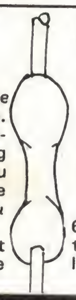

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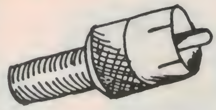
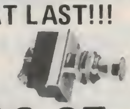


	1-9	10+
Nickel plated plug	60c	50c
Gold plated plug	$2.50	$1.95
Gold plated chassis socket	$2.95	$2.25
Metal line socket	50c	45c

AT LAST!!!



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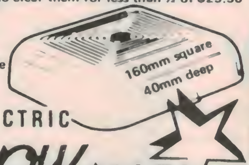

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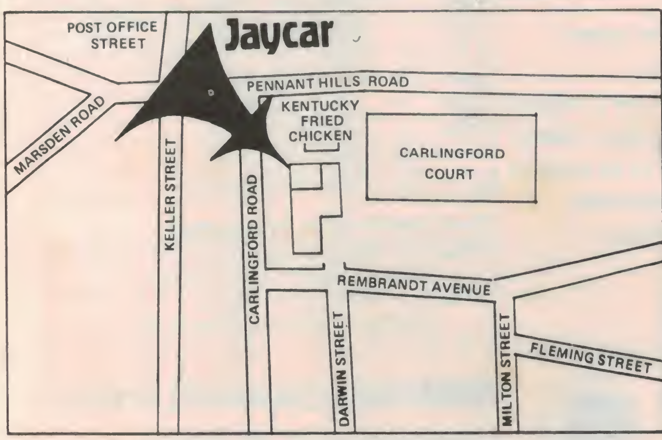

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Sizes in mm
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.033Mfd 100V Greencaps	14c	70c
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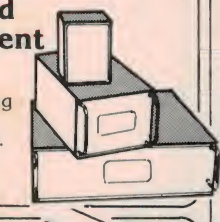

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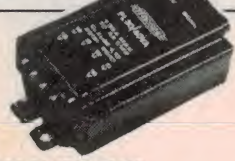

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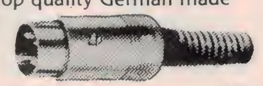

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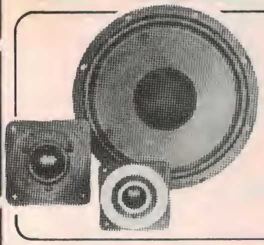

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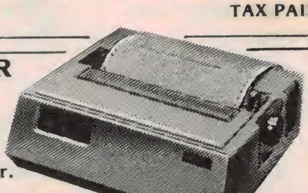

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ETI-4

Universal dc-dc inverter

This inverter can be configured to suit a wide variety of applications — powering our audio amplifier modules from a 12 V battery, powering 12 V equipment from a 24 V or 32 V battery, deriving a high voltage supply from a low voltage dc source etc, etc.

David Tilbrook
Roger Harrison

WE'VE CALLED this a 'universal' dc-dc inverter as it has been designed so that, simply by winding the appropriate secondary, or secondaries, on the output transformer you can derive almost any dc output voltage(s) you want. Thus, this project can be used to power any of our audio power amplifier modules (ETI-470, ETI-477, ETI-480, ETI-499), with perhaps the exception of the ETI-466 300 W amp. You can power the ETI-565 HeNe laser and the ETI-452 Guitar Practice Amp, or any other project or device you desire, providing it falls within the power rating of the inverter.

We described a dc-dc inverter power supply to power a PA/guitar amp employing one of our 100 W '480 modules way back in May 1977. This was the ETI-481PS which provided ±40 V rails from a 12 V battery. It ran at 20 kHz and required special rectifier diodes, a potcore and a ferrite transformer assembly — all of which are now very difficult, if not impossible, to obtain. Since we described the Series 5000 stereo power amplifier in the January-February-March '81 issues, many readers have sought to adapt it for use in their vehicles (car/truck/sin bin . . .). Some managed to chase up the parts for the ETI-481PS, but they have now virtually 'dried up' and we have been pressed to do a 'replacement'. Well, this is it, albeit with some refinements.

We decided to make this inverter a 'universal' project as it struck us there are wider applications than was first envisaged. Besides, we've had a number of requests for a 12 V inverter to power the ETI-565 HeNe laser, both to provide portability and to free it from mains operation for improved safety. It seems that many schools have built the laser for use in their science labs.

Design considerations

A number of factors were considered of prime importance when we tackled the design of this inverter. First came the frequency of oscillation. Would we have a low frequency design, which eases component selection and ensures their availability, or set the oscillation frequency above the audio band? A third option was to do something between those two extremes. Cost, size and component availability were also important.

The problem with a low frequency inverter, operating at — say — 2 kHz or less, is suppressing the switching 'spikes' that appear on the power supply rails. This can be difficult and these spikes almost inevitably create interference in low-level input stages. As the spikes contain predominantly odd harmonics the result is a cacophony of buzzes that is constantly present. Rectifier filter capacitors at the lower frequencies are, by necessity, large and we didn't want a bulky project.

Setting the inverter oscillation frequency above the audio band, at 20 kHz for example, gets rid of the above problem but introduces several others. Circuit techniques that work at low frequencies require specialised components at 20 kHz. Hence, a different inverter technique is necessary, and this inevitably increases costs and specialised components often prove hard to get — which became the major problem with the ETI-481PS which ran at about 25 kHz.

We chose the median course. Setting the oscillation frequency at around 6-7 kHz puts the odd harmonics where they (mostly) won't be heard. Filtering is easy and suitable capacitors are compact.

We wanted a design that used a minimum number of components, so that the project would be compact, but consistent with the other restraints. There are three common techniques employed in transistor dc-dc inverters these days — the self-excited single transformer circuit, the self-excited dual transformer circuit and the driver inverter.

The self-excited single transformer inverter is by far the simplest. The general form of this inverter is shown in Figure 1. The transistors operate in push-pull and feedback is taken from a winding on the output transformer. It

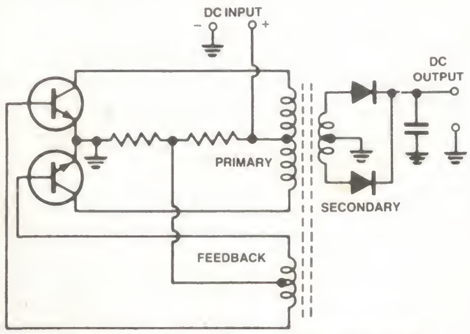


Figure 1. **Typical circuit of a self-excited single transformer dc-dc inverter. Efficiency of this type of circuit often exceeds 90%, with correct choice of transistors.**

has two great advantages — simplicity and high efficiency. With proper choice of transistors, efficiency can be in excess of 90%. However, at the sort of powers

we envisaged the inverter would have to deliver — around 200 W or so — switching transistors with suitable current ratings and low saturation voltages (for that's where you lose efficiency) are not cheap, or readily available. Germanium switching transistors are the best. Tried to buy a 20 A germanium switching transistor lately? Some MOS switching devices are also suitable, but still hard to get. You could parallel transistors of lower current rating but the traditional method of using emitter 'ballast' resistors severely affects efficiency. By using a special primary winding on the transformer, as shown in Figure 2, the devices are essentially in parallel but collector-emitter current sharing is done in the transformer primary. Base current sharing is effected by the series base resistors.

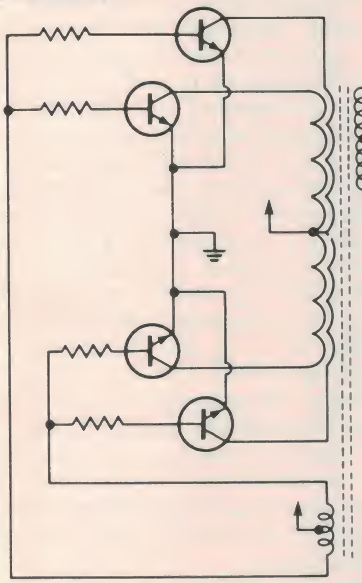


Figure 2. **Obtaining more power output from the simple self-excited inverter by means of 'paralleling' transistors with a special, quadrifilar-wound, primary. For high power use, lower cost transistors can be used.**

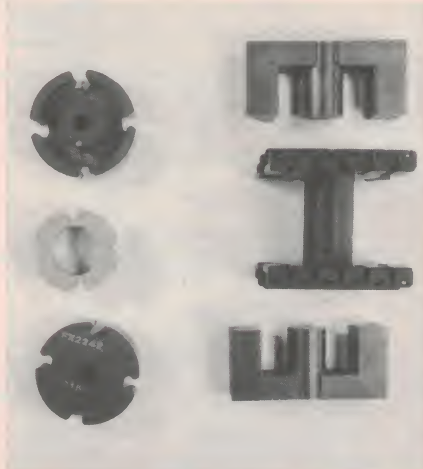
Thus, common-or-garden transistors, like 2N3055s, can be used and little power is lost here. The major drawback is attaining the required oscillation frequency. For this sort of inverter, the oscillation frequency is given by:

$$f \cong \frac{V_{supply}}{4N\delta_m}$$

where: f is frequency of oscillation
V_{supply} is dc input
N is primary turns, collector to centre tap
δ_m is magnetic properties of transformer core

Thus, for a given voltage and core properties, N must be relatively small to achieve the required frequency of oscillation. But here comes a catch. The feedback winding must develop enough voltage to drive the base such that the transistor(s) saturate properly. In practise, this means about 3 V. If the dc input is 12 V, you need a turns ratio of 4:1 between the primary and feedback windings. If you make the feedback winding (centre tap to one set of bases) one turn, then the primary has to be four turns. With available cores, the oscillation frequency did not even approach what we wanted.

A driven inverter is more complex, but it overcomes the problem just outlined. A typical arrangement is shown in Figure 3. This employs a low power, self-excited push-pull oscillator driving a set of push-pull output transistor switches which drive the output transformer. The old ETI-481PS inverter was of this type. Efficiency is the greatest drawback of this type of circuit. The driving oscillator always draws significant power. You can achieve efficiencies



The transformer assemblies we used. At left is the FX2242 potcore assembly; right is the Philips EC52/24/12 assembly. Note the ferrite 'Es' of this assembly have round centre legs. The bobbins are shown in the middle.

of 80%, typically, but at 200 W output, you're losing 40 W and in a battery system, this is not good.

We settled on the self-excited dual transformer technique, illustrated in Figure 4. Here, a separate feedback transformer is used and it is this which controls the frequency of oscillation. This enables the choice of the right sort of core to obtain realistic turns ratios and the desired frequency of oscillation. We managed to use a common potcore for the feedback transformer (a 36 mm diameter FX2242 type) and an EC-core for the output transformer of a type we have used previously (in the ETI-1505 fluorescent light inverter). Supply rail filtering can be done quite effectively with common greencaps. Ordinary 2N3055 transistors — which cost less than a dollar these days — can be employed, thus keeping the cost down. ▶

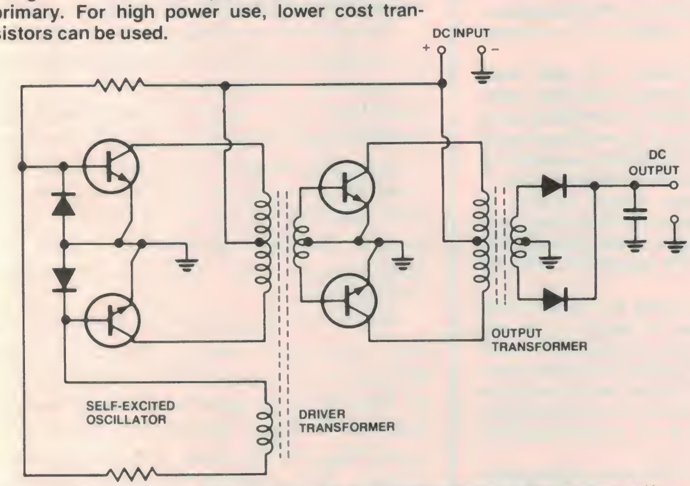


Figure 3. **Typical circuit of a driven dc-dc inverter where a low power self-excited oscillator drives a set of transistor switches which drive the output transformer. Of the three types, this technique has the poorest efficiency.**

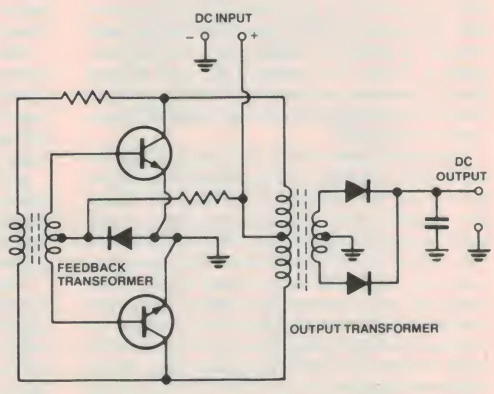


Figure 4. **Circuit of a self-excited dual transformer dc-dc inverter where the feedback is separated from the output transformer. In this circuit, the oscillation frequency is determined by the feedback transformer. Efficiencies similar to the Figure 1 circuit can be achieved.**

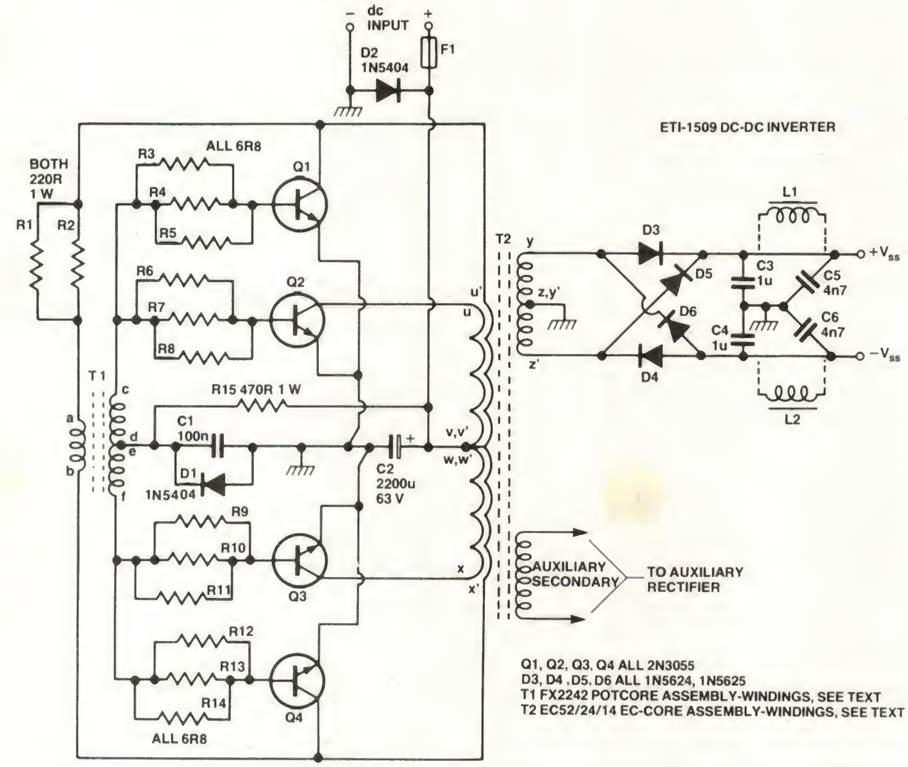


Figure 5. Circuit of the universal dc-dc inverter. The two inductors shown at the rectifier output, L1 and L2, are only necessary if extra filtering of the dc output is necessary. These can be any value between about 1 mH and 10 mH. Speaker crossover inductors are ideal for this application. Choose inductors rated to carry the dc output current. At low currents (200 mA or less, say) RF chokes will suffice.

The circuit of the inverter is shown in Figure 5.

As it was to be a 'universal' inverter, the output transformer was designed to provide a simple volts/turn ratio for the secondary, making it easy to calculate and wind the secondary for the required output. The ratio is two volts per turn. A 'Table of Suggested Outputs' has been drawn up for a variety of applications. Note that more than one secondary can be wound on the output transformer if required.

Construction

The inverter can be housed in any convenient enclosure and we have shown only general construction as layout is not particularly critical. A suggested layout is shown in the wiring diagram. A metal case is assumed. Four tagstrips are used as tiepoints to terminate the two transformers and to mount the resistors, capacitors and diodes. The four transistors can be mounted to the case. No heatsink is necessary as little power is dissipated, but the transistor cases need to be insulated so use insulating washers and bushes as shown in the accompanying assembly diagram.

The primary windings of T1 are terminated to a 7-lug tagstrip. The collector of each transistor is connected to the appropriate lug on the tagstrip using heavy duty insulated hookup wire, preferably 32 x 0.2 mm or heavier, as switching currents can be in excess of 20 amps. The mounting lug of the 7-lug tagstrip is used as a ground tiepoint for the transistor emitters. Connect them up with heavy duty hookup wire too. Capacitor C2, the input protection diode D2 and the bias resistor R15 also mount on this tagstrip.

Two 5-lug tagstrips are used to terminate the feedback transformer, T1, and to support the base current limiting resistors and several other components.

The rectifier components are mounted on another tagstrip. The high frequency bypassing components should be mounted on a tagstrip away from the rectifier and very close to the hole where the supply output wires exit from the case. If extra filtering is necessary (by the addition of L1 and L2) then it is easily inserted between the rectifier tagstrip and the 3-lug tagstrip containing C5 and C6.

When laying out the components to suit your case, keep the two 5-lug tagstrips fairly close to the four transistors so that the base current limiting resistors can be easily mounted between the tagstrips and the base pins of the transistors. Also, mount the 7-lug tagstrip that terminates the primaries of T1, close to the transistors so that high

HOW IT WORKS — ETI-1509

The circuit is a push-pull self-oscillating inverter with feedback provided by transformer T1, output being taken from T2. The moment the supply voltage is connected, current flows through the 470 ohm resistor R15, through the secondary of T1 (c-d-e-f) and the base current limiting resistors of the transistors Q1 to Q4. One of these transistors will turn on as circuit balance is not perfect and device characteristics are not matched. If, for example, Q1 commences to turn on, current will flow through the u'-v' primary of T2. This causes a magnetic field to build up in the transformer core creating a positive voltage on x' (x goes positive too). This puts a positive voltage on b of T1's primary which is wound and connected so that a positive voltage here causes a positive voltage on c of the secondary. Thus, the bases of Q1 and Q2 are driven positive, turning them hard on and the bases of Q3 and Q4 are driven negative, turning them hard off.

Since the primary of T1 acts as an inductor, the current flowing in it increases linearly for as long as the voltage is applied until finally the magnetic field intensity reaches a maximum, where the transformer core saturates. At this moment, the impedance of the core drops since the saturated core cannot maintain the relatively high inductance of the primary. The decreased impedance causes an increase in current flowing in the primary, driving the core even further into saturation until most of the coupling between the primary and secondary is lost. This causes the drive voltage to the bases to disappear. Current stops flowing in the transformer and the magnetic field starts to collapse. This causes the voltage sense of each winding to reverse. Thus, u and u' on T2 go positive and x-x' go negative. This causes b on T1 to go negative and thus c goes negative, removing charge from the bases of Q1 and Q2 which turn off. At the same time, f goes positive, turning Q3 and Q4 on. The whole sequence of events then repeats for the opposite 'side' of the oscillator, until once again, Q1 and Q2 are driven on and oscillation results.

The frequency of oscillation depends primarily on the core material of T1, the turns on its primary winding (a-b) and the applied voltage. In this case the frequency is around 6 - 7 kHz. Resistors R1 and R2 provide control of the feedback and diode D1 provides a return path for the base emitter current to the transistors when the secondary voltage of T1 reverses direction.

The output transformer, T2 has been arranged to provide a simple volt/turn ratio. Common, low cost 2N3055 transistors have been used and the special, quadrifilar-wound, primary is a means of effectively connecting pairs in parallel, as discussed in the main text.

Although a full wave bridge rectifier is shown here, any rectifier circuit may be used on the output. Filtering is readily provided by low value non-polarised capacitors, such as greencaps.

This inverter circuit, like the simple self-excited inverter shown in Figure 1, has the advantage that, when an overload or short circuit is applied to the output, oscillation cannot be maintained and it stops, which is not the case with a driven inverter. Thus, some protection is afforded both the inverter and the equipment connected to it.

Diode D2 prevents damage by blowing the fuse should the dc supply input be connected in reverse.

PARTS LIST — ETI-1509

Resistors .... all ½ W, 5% unless noted
R1, R2 .... 220R, 1 W
R3 — R14 .... 6R8
R15 .... 470R

Capacitors
C1 .... 100n greencap
C2 .... 2200u/63 V axial electro. (or 2500u/50 V)
C3, C4 .... 1u greencap
C5, C6 .... 4n7 ceramic

Semiconductors
D1, D2 .... 1N5404
D3, 4, 5, 6 .... 1N5624, 1N5625
Q1, 2, 3, 4 .... 2N3055

Miscellaneous
T1 .... FX2242 potcore assembly (windings, see text).
T2 .... Philips EC-core assembly (windings, see text).
2 x EC52/24/14 cores (4322-020-52520)
1 x former, no tags (4322-021-33020)
clamp assembly:
1 x 52PLATE
1 x 55UBOLT
2 x 632NC2A

Two 7-lug tagstrips; two 5-lug tagstrips; one 3-lug tagstrip; chassis or box as required; winding wire — 1 mm and 0.4 mm enamelled copper wire; 32 x 0.2 mm hookup wire; 10 x 0.2 mm hookup wire; nuts, bolts etc.

Price estimate $30 — $35

current carrying leads are kept short.

Make sure you have enough room to mount both T1 and T2. A single bolt through the centre hole of the T1 potcores will secure it but use a fibre washer under either the head of the bolt or under the nut to prevent cracking one of the potcore halves.

If you use a chassis that comes in two halves (like we did on our prototype) mount all the tagstrips and components on the one half so that all the ground tie points are connected together whether the case is split in half or not. If you use a box with a lid (like a diecast box, for example) mount all the components and tagstrips either on the lid or in the box, for the same reason.

When you have a layout finalised for the housing you're using, it's best to assemble all the electronics first, leaving the transformers till last. *Then* wind the transformers. Use our Table of Suggested Outputs and the Transformer Winding Details as a guide to assemble the two transformers. When you've done these and checked that all is correct, mount the transformers and wire them up.

For the dc input leads, use heavy duty cable or hookup wire, remembering that 20 A or so may be passing through it. Don't forget the line fuse.

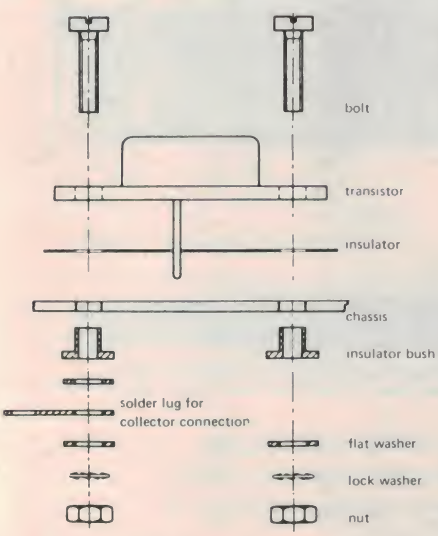
Firing it up

Simple. If you're confident you've wired it up correctly (*and* checked it), hook a multimeter to the dc output and connect power to the dc input. You should hear the transformers 'sing' immediately at quite a high pitch (around 6 kHz if your pitch sense is that good). The output voltage should rise to what you require, also. If you don't hear the transformers sing, then switch off and reverse the primary (a-b) connections of T1. Switch on and the inverter should burst into life. If it doesn't — or worse, bursts into flames! — switch off and take a look at your wiring. Correct any faults before trying again. In particular, make sure you have D1 the right way round.

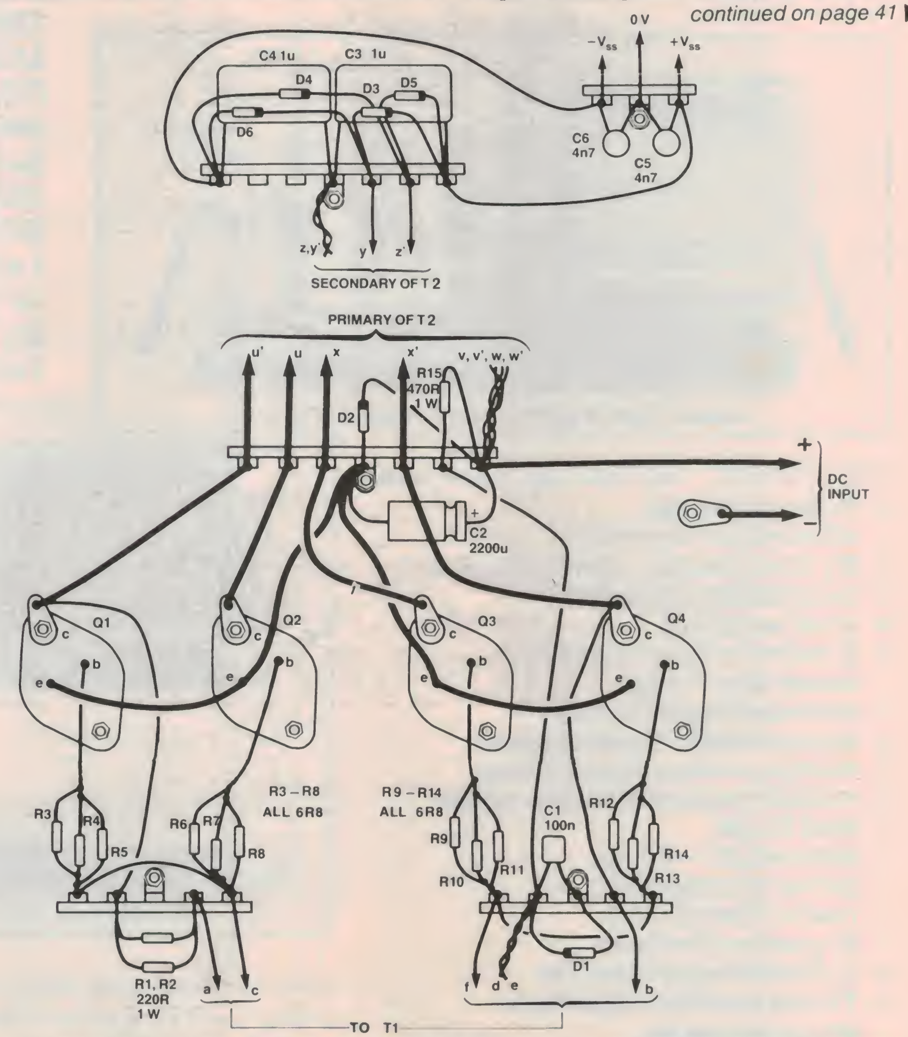
If all is working as it should, you could try and assemble a 'dummy' load for the output. A suitable set of power resistors will do. The exact resistance will depend on the supply and the load current it has to supply. We'll have to leave this to you.

Under load, the output voltage should be within a few per cent of what you require and power dissipation of the

continued on page 41 ▶



Mounting the power transistors.



General wiring diagram of the inverter. Layout is not critical. However, use heavy duty (32 x 0.2 mm) hookup wire for the heavy leads shown here for wiring the collectors and emitters of the four power transistors. Capacitors C5 and C6 provide high frequency bypassing of the output rails. Mount them close to where the supply output leads exit the case.

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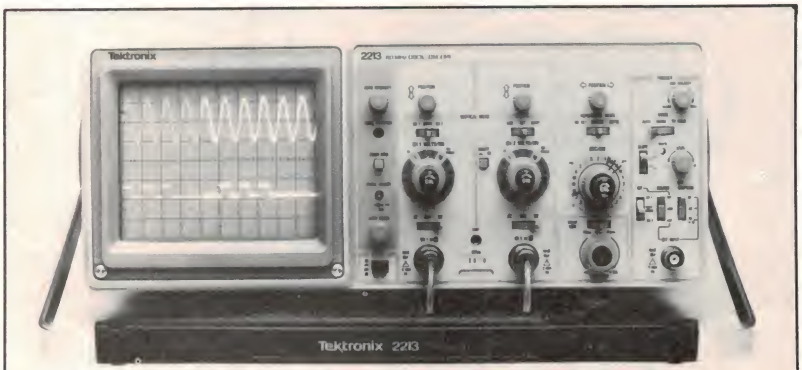

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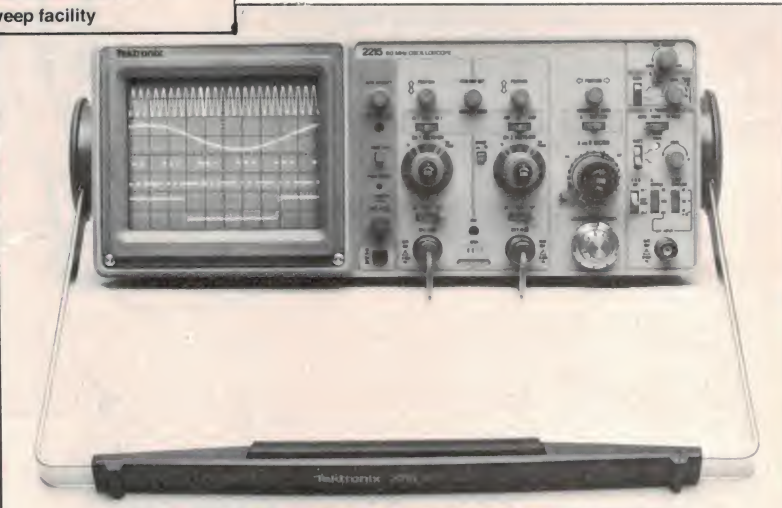

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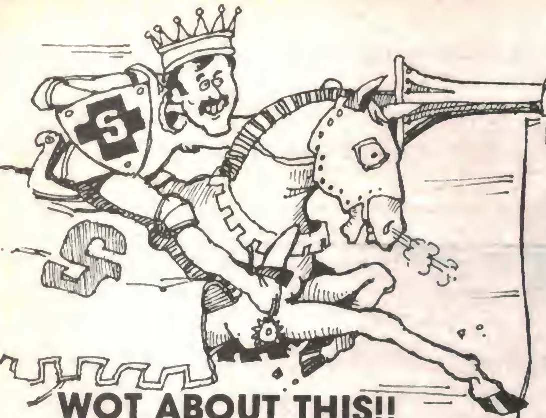

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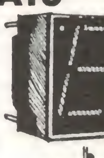

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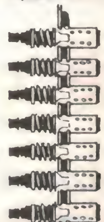

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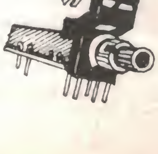

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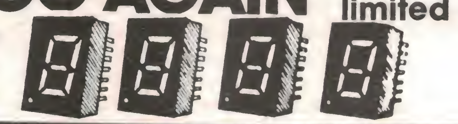

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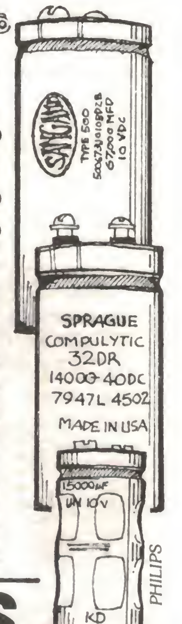

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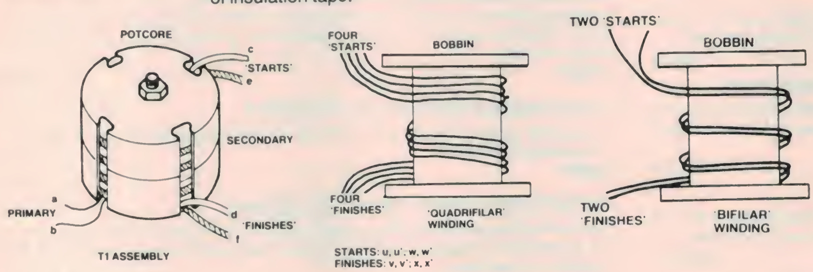
TRANSFORMER WINDING DETAILS

T1

Core	FX2242, 36 mm dia. potcore, two halves with single section bobbin.
Wire	enamelled copper wire, about one metre of 1 mm diameter wire and about 1.5 metres of 0.4 mm.
Primary (a b)	20 turns of 0.4 mm wire wound evenly on the bobbin. Cover with a layer of insulation tape. Note that b is the start.
Secondary (c-d, e-f)	4 turns, bifilar wound (see diagram), of 1 mm wire spread over bobbin. Cover with a layer of insulation tape. Bring out the starts at one end of the bobbin, finishes at the other. Starts are c and e.
Notes	The above refers to T1 wound for a **12 V (nominal) supply.** On a **24 V (nominal) supply,** the primary (a-b) and secondary (c-d, e-f) should be doubled (i.e: 40 turns and 8 turns, bifilar, respectively). On a **32 V (nominal) supply,** the primary turns (a-b) should be increased to 50, the secondary (c-d, e-f) to 10 turns, bifilar.
Winding order	Wind the primary (a-b) **first.**

T2

Core	Philips EC-core assembly, as per the parts list.
Wire	enamelled copper wire, 0.4 mm dia. — length to suit application, and about two metres of 1 mm dia.
Primaries (u-v, u'-v', w-x, w'-x')	use 1 mm wire wound **quadrifilar** (see diagram), two volts per turn. i.e: for 12 V (nominal) supply — six turns; for **24 V (nominal) supply** — 12 turns; for **32 V (nominal) supply** — 16 turns.
Secondary (y-z, y'-z')	0.4 mm or 1 mm wire (to suit current) bifilar wound, two volts per turn. i.e: for ±**40 V supply rails** — 20 turns; for ±**50 V rails** — 25 turns, etc. See table of suggested outputs.
Winding order	Wind the quadrifilar primaries (u-v, u'-v', w-x, w'-x') **first.** Cover with two layers of insulation tape.



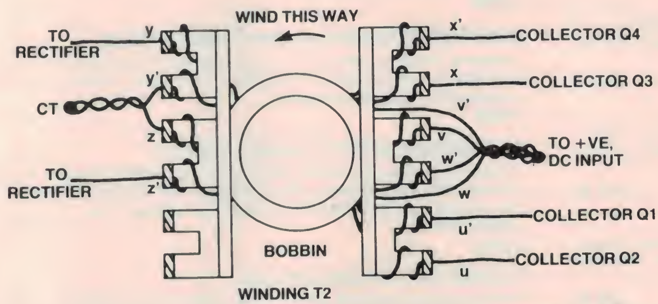


TABLE OF SUGGESTED OUTPUTS

OUTPUT	T2 SECONDARY	RECTIFIER	APPLICATION
±50 V	25 turns bifilar	2 x fullwave	Power 2 x ETI-477 (Series 5000) or 1 x ETI-498 module.
±40 V	20 turns bifilar	2 x fullwave	Power 2 x ETI-480 (50 W or 100 W versions) or 2 x ETI-470 modules.
±15 V	8 turns bifilar (Note 1)	2 x fullwave	Auxiliary secondary to power a preamp. e.g: ETI-481M guitar mixer/preamp or ETI-498 PA preamp.
1400 V	700 turns (Note 2)	voltage doubler (Note 2)	Power ETI-565 laser
12 V (from 24 V or higher dc input)	7 turns (Note 1)	fullwave bridge	Power 12 Vdc equipment from 24 V or higher dc input.

Note 1. This takes rectifier voltage drop into account.
Note 2. The secondary can drive the ETI-565 laser power supply directly, replacing the original power transformer.

▶ *from page 37*

transistors should be quite low. They should only get warm to the touch. (But don't touch them while the inverter's operating — you can get a 'belt'!) You will notice that the operating pitch of the inverter drops when a load is applied.

If all tests out well, hook up the inverter to the unit it is intended to power and try it out. With audio amp modules the 6 kHz oscillation frequency of the inverter should not be audible in the loudspeakers or should be a very, very long way 'down'. Where it is used in conjunction with a sensitive preamp, earthing loops and supply line induction into input leads and earths can cause 'break through' of the 6 kHz oscillation frequency. Take care with the routing of supply leads from the inverter. Keep them away from input leads and make sure the audio equipment is earthed at a single point, either at the power supply chassis or at the dc input common (negative).

Avoid radiation from the inverter inducing 6 kHz breakthrough into any equipment by keeping the inverter physically separate from such equipment. Both transformers have very little external field, but the wiring of the inverter carries considerable switching currents and can induce small, but significant, signals into sensitive audio or RF input leads. If you intend mounting it inside the equipment case, build it in a separate, shielded (i.e: all metal) enclosure and mount that inside the equipment but away from input circuitry.

Performance

This project was hastily built up one Saturday, from a 'lash-up' prototype, to power the ETI-498/499 PA amp for a function the following day! It worked first off. We didn't even have to reverse the primary of T1 to get the feedback phase correct!

Performance was faultless — for both the inverter and the PA.

Occasionally you win some! Breakthrough of the 6 kHz oscillation frequency was only evident with the low level mic gain and the volume pot on the PA amp set full up. Two secondaries were wound on the inverter output transformer (T2), one to provide the power amp with ±50 V and the other to provide the preamp with ±15 V. The breakthrough was subsequently found to be primarily due to a double-earthing problem.

The PA amp ran from a 12 V battery faultlessly for an all-day event. The inverter ran cool — admittedly, it was midwinter and quite cold, but efficiency approaches or exceeds 90% and in this sort of application, average dissipation is very low. ●

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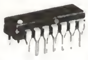

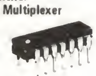

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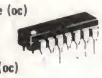
74LS244	Octal Buffer/Driver	$3.55
74LS245	Octal Bus Transceiver	$2.95
74LS257	Quad 2 Input Multiplexer Tri-State	85
74LS258	Quad 2 Input Multiplexer Tri-State	75
74LS259	8 Bit Addressable Latch	$2.50
74LS266	Quad EXCLUSIVE NOR Gate (oc)	$1.25
74LS273	Octal D Type Flip Flop	$2.95
74LS365	Hex Buffer with Common Enable	60
74LS366	Hex Inverter with Common Enable	60
74LS367	Hex Buffer 4 Bit and 2 Bit	$1.25
74LS368	Hex Inverter 4 Bit and 2 Bit	70
74LS373	Octal Transparent Latch	$2.95
74LS374	Octal D Type Flip Flop	$2.50
74LS393	Dual LS93	$3.50



SPEECH SYNTHESISER

DT1050	National Digitalker Processor & ROM Set	$95.00
DT1057	National Digitalker Second ROM Set	$69.00

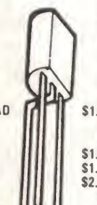
Send SAE for more details. NOTE new low price. Data sheets included in chip sets.

LINEAR DEVICES

ZN414	$2.50	LM381N	$3.95
TL061	$2.45	LM381AN	$5.95
TL062	$2.45	LM382	$2.60
TL064	$4.75	LM394CH	$5.95
TL071	98	NE555	35
TL072	$1.45	LM7555	$1.95
TL074	$3.50	LM556	$1.10
TL075	$3.50	LM567	$1.95
TL081	65	LM570	$7.50
TL082	95	NE571	$6.50
TL084	$2.95	LM723	$1.45
TL085	$3.50	LM741	40
LM234	$3.50	LM747	$1.95
LM301	60	LM1496	$1.98
LM307	90	LM3046	$1.45
LM308	$1.25	LM3080	$1.30
LM311	95	LM3130	$1.80
LM319	$3.50	LM3140	$1.45
LM324	$1.20	LM3900	95
LM334	$2.50	LM3914	$6.50
LM339	95	LM3195	$4.50
LF347N	$3.50	LM39152	$12.50
LM348	$2.25	LM4136	$1.85
OM350	$9.50	LM4558	$1.50
LM361	$3.75	LM5534N	$1.55
LM380	$1.48	LM5534AN	$2.00

DISCRETE DEVICES

VN88AF	$3.00	BC547	15
BCY71	95	BC548	15
JDT9203	$1.95	BC549	15
40411	$5.00	BC550	65
MJ15003	$4.75	BC556	65
MJ15004	$4.75	BC557	18
2SJ49(P)	$6.50	BC558	18
BDV64B	$5.95	BC559	18
BUX80	$9.50	BC639	34
2SK134(N)	$6.50	BC640	34
BU105	$12.50	BD266AD	$1.50
MPSA05	95	BD139	53
TIP31A&B	90	BD140	53
TIP32A	90	MJ2955	$1.50
TIP2955	$1.20	2N3055	$1.50
TIP3055	$1.20	2N3442	$2.50
MPF102	95	2N3569	45
MPF105/2N5459	85	2N3638	35
MPF106/2N5485	78	2N3643	45
MPSA55	95	2N3645	45
MFE131	$1.98	2N3773	$5.00
BF115	75	2N4258	35
BF200	95	2N5484	85
BF469	$1.65	2N5087	65
BF470	$1.65	2N5589	$8.50
MJE340	$1.98	2N5590	$9.50
MJE350	$1.98	2N5591	$12.50
ZTX501	45	2N5245	90
BC337	25	2N6027/D13T1	58
BC546	65	TT800	85
BF469	$1.65	2N3566	45
BF470	$1.65		



SPECIAL FUNCTION

SAB0600	Door Chime	$9.95
AY-1-5050		$9.50
TEA-1002	PAL Colour Encoder	$17.50
TDA-1022	Bucket Brigade	$29.50
EXAR 2206	Function Generator	$5.95
MDC-3020	TRIAC Opto Coupler	$2.50
MM 5837	Noise Generator	$3.90
TA 7205P	Audio Amp	$4.50
7216A	Frequency Control Display Driver	$47.50
SN 76488NF	Sound Effects Generator	$5.95
AY-1-0212	Top Octave Synthesiser	$19.50

Z-80A/6800

Z-80A CPU 4MHz	$8.50	Z-80A DART 4MHz	$32.95
Z-80A PIO 4MHz	$8.50	Z-80A DMA 4MHz	$20.95
Z-80A CTC 4MHz	$8.50	6802 CPU	$11.00
Z-80A S10/0 4MHz	$20.95	6810 RAM	$4.95
Z-80A S10/1 4MHz	$20.95	6821 PIA	$4.95
Z-80A S10/2 4MHz	$20.95		

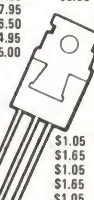
ZENER DIODES

From 3.3V to 33V 35

JAYCAR DEALER: G&J Electric, Forresters Beach NSW 2260
Ph: (043) 845787

MEMORIES

		1-7	8 up
2102	1K x 1 RAM	$1.95	$1.65
2114-3	1K x 4 RAM 350nS	$2.45	$2.00
4116	16K x 1 Dynamic RAM 250nS	$2.50	$2.00
6116	2K x 8 CMOS RAM	$12.50	$9.90
2708	1K x 8 EPROM	$7.95	
2716	2K x 8 EPROM (Single +5V)	$6.50	
2532	4K x 8 EPROM (Single +5V)	$14.95	
2564	8K x 8 EPROM (Single +5V)	$35.00	



VOLTAGE REGULATORS

7805	5V+ Regulator TO-220/amp	$1.05
7905	5V– Regulator TO-220/amp	$1.65
7812	12V+ Regulator TO-220/amp	$1.05
7912	12V– Regulator TO-220/amp	$1.65
7815	15V+ Regulator TO-220/amp	$1.05
7915	15V– Regulator TO-220/amp	$1.65
78L12	12V+ Regulator 100mA	$1.00
78L15	15V+ Regulator 100mA	$1.00
79L15	15V– Regulator 100mA	$1.00
LM323	3amp 5V TO-3	$1.50
LM309	1.5 amp 5V TO-3	$7.50
LM317T	2-30V adjustable 1 amp TO-220	$2.80
LM317KC	2-30V adjustable 3 amp TO-3	$6.50
LM318H		$3.50
LM337K	3 amp variable 2-30V TD3	$9.50
LM396K	10 amp variable 1.25-15V TD3	$19.50

LED's

5mm Red	15	3mm Yellow	28
5mm Green	26	Rectangular Red	40
5mm Yellow	30	Rectangular Green	40
5mm Orange	28	Rectangular Yellow	40
3mm Red	18	Flashing Red	49
3mm Green	28	Flashing Red 10+ each	45

BRIDGE RECTIFIERS

W04	68
P04	$2.95
MDA3504	$4.50

OPTO

CQY89 Infra Red LED	$1.25	FND500 "	$1.35
BPW50 Infra Red Diode	$2.95	FND507 "	$1.75
LT302 7 seg Display	$1.45	LT547 "	$2.95
LT303 7 seg Display	$1.45		

DIODES

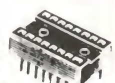
IN4002	8	BA102	25	BYX21L/200R	$1.90
IN4006	20	BA114	25	OA91	12
IN5404	35	BA215/219	25	OA202	50
IN914	5	BR100	95	OA697	20
BAW62	29	BYX21L/200	$1.90	5082-2800	$2.75

IC SOCKETS — SOLDER

8 Pin	25	18 Pin	35	24 Pin	50
14 Pin	30	20 Pin	38	28 Pin	60
16 Pin	35	22 Pin	40	40 Pin	70

QUALITY WIRE WRAP IC SOCKETS

14 Pin	85	22 Pin	$1.40
16 Pin	$1.05	24 Pin	$1.75
18 Pin	$1.35	28 Pin	$2.25
20 Pin	$1.45	40 Pin	$2.65



DIL PLUGS AND COVERS SOLDER TYPE

14 Pin Plug	85	16 Pin Cover	25
14 Pin Cover	25	24 Pin Plug Only	$2.50
16 Pin Plug	95		

CRYSTALS

Case Style: HC-33/U		4.9152MHz	$6.50
1.000MHz	$12.50	5.000MHz	$5.50
1.8432MHz	$9.50	8.867238MHz	$5.50
2.000MHz	$7.50	10.000MHz Parallel Resonant	$9.50
3.000MHz	$7.50		
Case Style: HC-18/U		12.000MHz	$5.50
4.000MHz	$6.50	16.000MHz	$5.50
4.43MHz	$6.50	20.000MHz	$7.50

JAYCAR

125 YORK ST SYDNEY 2000
Ph. 2646688 Telex: 72293
Mail Orders To:
Box K-39 Haymarket 2000

POST AND PACKING CHARGES
$5-$9.99 ($1.20) $10-$24.99 ($2.40)
$25-$49.99 ($3.50) $50-$99.99 ($4.60)
$100 up ($6.20)

NEW SHOP HOURS
Mon-Fri 8.30 to 5.30pm
Sat 8.30 to 12.00pm
Thurs night to 8.30pm

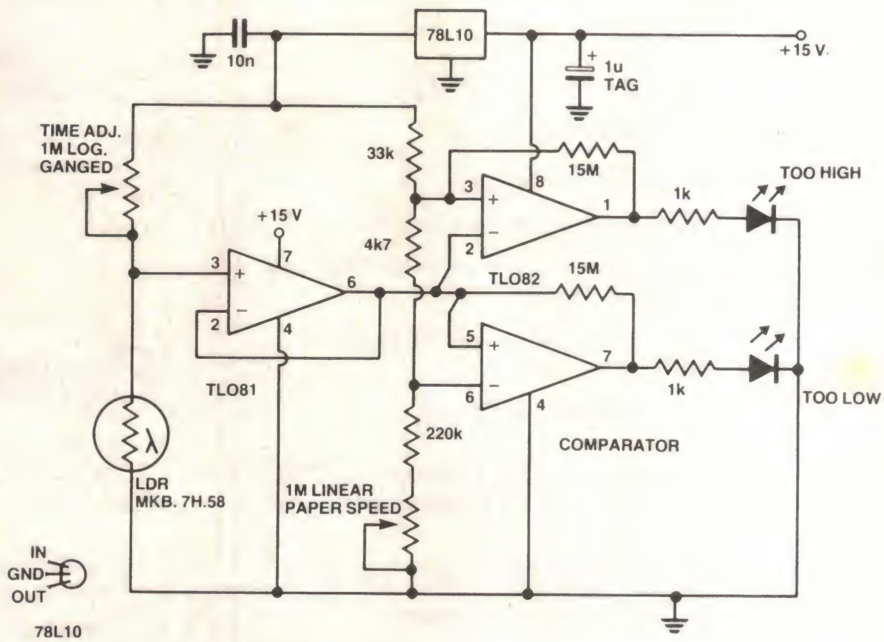
Exposure analyser for black and white prints

This exposure analyser, coupled to a timer, simplifies making black and white prints. A light intensity reading is taken from the image, the 'time' control is adjusted to the balance point and lights two LEDs, the timer is started — and your enlarger is turned on for the correct time.

Peter Cox

THE REASON for building an exposure analyser such as this was to avoid making test strips for different negatives or for different degrees of enlargement. Commercially available analysers are often either fiddly to use or comparatively expensive. Some operate by adjusting the aperture of the enlarger and keeping a constant exposure time, which is less satisfactory than varying the exposure time as most enlarger lenses give better performance when stopped down from maximum aperture.

There have also been several analyser circuits in electronics magazines, but I found these to be either too full of drafting errors to be practicable or, in one case, going into technical overkill — using 23 ICs, digital exposure readout to tenths of a second, and requiring an IC (CA3140) to perform better than its published specifications. So I decided to design and build my own exposure analyser.



NOTES:
1. TLO81, TLO82 ARE BIFET OP-AMPS, VERY HIGH INPUT IMPEDANCE: 10^{12} OHMS TYPICAL.
2. BYPASS 78L10 REGULATOR WITH CAPACITORS SHOWN: MAKE SURE THEY'RE CLOSE TO THE IC.
3. SET 1M LOG. (GANGED) POT TO 50% ROTATION: RESISTANCE SHOULD BE CLOSE TO 100k. WITH 2k 'CALIBRATE' POT NEAR MIDDLE, PICK CAPACITOR TO GIVE PULSE DURATION OF 10 SECONDS. TRIMPOT HAS ADJUSTMENT RANGE OF +40%, −20%.

USE:
1. SET TIME ADJUST POT TO 10 SECONDS. MAKE A PRINT THAT REQUIRES 10 SECONDS EXPOSURE: WITH LDR MEASURE MID-GREY OR HIGHLIGHTS (NOT BOTH) AND ADJUST PAPER SPEED POT FOR BRIDGE BALANCE: BOTH LEDS LIGHT.
2. PUSH START BUTTON TO BEGIN TIMING CYCLE.

Circuit operation

The circuit is in two parts, excluding the power supply: the light-measuring comparator has an LDR in one leg of a resistive bridge.

As the LDR resistance can be up to 20-30M, the voltage is buffered by a TLO81 BiFET op-amp. Voltages from the bridge are applied to a window voltage comparator made from a dual BiFET IC. A small amount of hysteresis is provided by the 15M resistors. I didn't worry about using buffering on the other side of the bridge because of lower resistances.

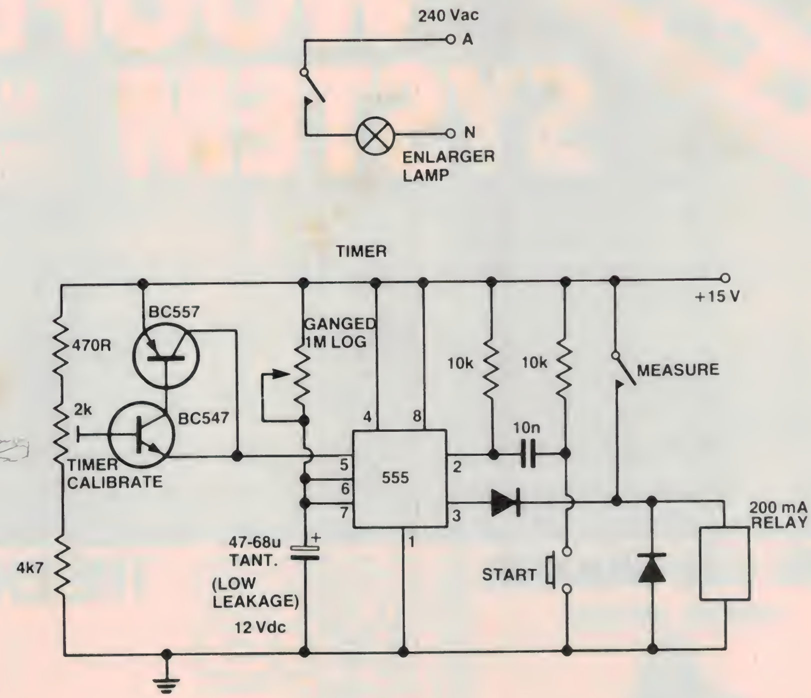
The bridge is fed from a 10 V voltage regulator, as otherwise the IC output voltages may be restricted, the inputs working within 0.75 V or so of the posi-

tive rail. The time adjust pot, a 1M log unit, is ganged, and the other section determines the output duration of a 555 monostable. A timer calibrate pot is included to simplify setting up the timer.

The capacitor used in the 555 RC network should be very low-leakage, but ordinary tag tantalums seem to give consistent timings despite leakage currents of 50 nA/uFV (maximum quoted on ITT tag data sheet).

Parts

BiFET op-amps are freely available — singles, duals or quads; the TLO84 quad costs $3 or less. The LDR is made in Japan by Moririca, and is sold by Plessey Professional Components of Villawood NSW, costing $1 each in small quantities (when I bought some a while ago). There are many Moririca types available, so others may be more suitable than the ones I used; I bought the LDRs originally for use in an AGC amplifier, as an LDR-LED gain reduction element. ●



NEW STORE opening October in Carlingford

AT CARLINGFORD COURT NEXT TO KENTUCKY FRIED CHICKEN

SUB-WOOFER SYSTEM

MASSIVE PRICE BREAKTHROUGH!!!

A Sub-Woofer System makes a lot of sense. Apart from getting down to a genuine 30Hz you could actually save money over all.
For years we have been persevering with huge 12" 3 or 4 way systems in up to 120 litre cabinets to try to get down to— at best 45Hz. We have even duplicated our effort by having a stereo pair for this frequency!!!
Big 12" systems don't come cheap. With a Sub-Woofer you can forget about what happens below the non-stereo <100Hz region. Once that's done you are free to use a very compact (and generally far cheaper) system for stereo. Concert hall sounds in your lounge room without needing an auditorium to house your speakers.!!!
The profit you make from selling your 12" system could pay (or even exceed) the cost of the Sub-Woofer system. — AND you can get down to 30Hz!!!

1812 LIKE NEVER BEFORE. So too those big pipe organ records. This system is a must for the direct or digital disk enthusiast.
Now that "ELECTRONICS AUSTRALIA" have designed *a Mosfet Sub-Woofer filter/amplifier and speaker system you have no excuse.

JAYCARS' BULK BUYING PASSES SAVINGS ONTO YOU. TRULY A PRICE BREAKTHROUGH FOR SUB-WOOFER SYSTEMS.

*(With due respect to Thiele, Small, Snyder and others!)

THE SUB-WOOFER

MODEL SW 250

ONLY $79.50

This unit has been extremely popular with audio enthusiasts right across Australia! EA have designed a special crossover/booster amp just for this unit. Now you have no excuse to build a subwoofer system to enjoy those thrilling low notes from pipe organs, synthesisers, 1812 cannons etc!!

SPECS:
Diameter 10" (250mm) Cast Frame. QT=0.39. VAS=631
Power Handling = 100WRMS.
Free-air Resonance 32Hz ±1Hz
Voice Coil = 2" (51mm). Dia.
Magnet Assy = 3kg (6.6lbs).

A FREE SUB-WOOFER CABINET DESIGN IS PROVIDED WITH EACH UNIT!!

THE ENCLOSURE

ONLY $79.50

This compact 63 litre vented enclosure was specifically designed around the parameters of the SW250 Sub-Woofer. It follows the theory pioneered by the work of Thiele, Small and Snyder. The Jaycar enclosure is easy to build and is made of high quality durable materials. The heavy walled cabinet is covered with an attractive black vinyl veneer. All timber is pre-cut and the black grille is already made. Assembly takes less than one hour.
NB. The photo shows the prototype which was finished in white. The production units are only available in black
Freight anywhere in Australia only $10.00.

AMPLIFIER/FILTER UNIT

REF. EA JULY 1982

State-of-the-art power Mosfet technology combined with an active low pass filter results in a sub-woofer amp without equal anywhere!!

FEATURES: Around 100WRMS Drive capability.
Low pass (sub-woofer) filters on board.
Can hook-up to pre-amp out or power-amp out.
Power supply on board.
(Transformer needed. ONLY $39.50)

ONLY $79

AMPLIFIER/FILTER UNIT.
Amplifier Module $79
Transformer to suit $39.50

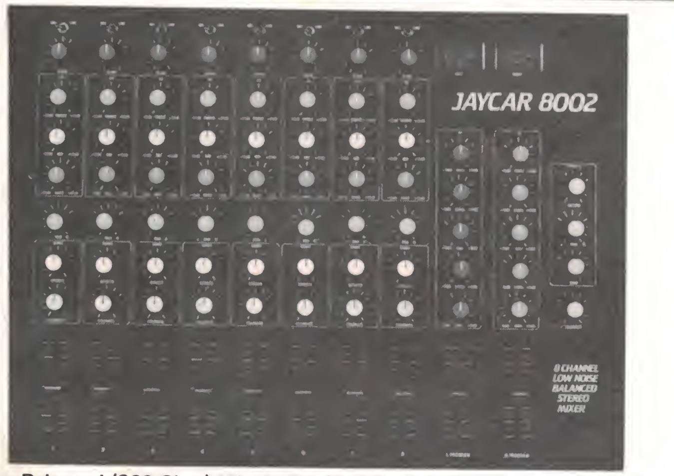
Metal case specially made to suit including front panel, hardware etc. (not a twin 25 case). Only $29.50
$148.00

Buy the lot for only $125.00 if you purchase the enclosure and woofer at the same time.

VOICE OPERATED RELAY KIT

Ref: EA July '82 Extremely useful circuit, has dozens of applications.

$14.50



- Balanced (600 Ohm) Mic. Inputs/Line Inputs.
- Cannon Connectors included in the price.
- Bass, Mid & Treble Equalization on each Input.
- "Effects" (i.e. Echo etc.) capability.
- Foldback and Stereo Pan on ALL 8 Inputs.
- 60mm Slide Faders used throughout.
- 19" Rack Mount capability (or Console Mount).
- Professional Black Front Panel with Format borders & multi-coloured knobs to assist function identification.
- VU Metering.

technical

- Signal-to-noise Microphone input — -75dB with ref to +4dBM
- Signal-to-noise line input — -90dB with ref to +4dBM
- Line out level +4dBM (0VU)
- Distortion less than 0.005%
- Power requirements 240VAC 50Hz 25 watts

dimensions

Width 483mm
Height 355mm
Depth (console mount) 150mm

SEND SAE FOR FULL DATA ON 5000 SERIES &/OR MIXER

JAYCAR DEALER: G&J Electric, Forresters Beach NSW 2260 Ph: (043) 845787

MOSFET MAGNIFICENCE

NEW STORE Opening October in Carlingford

AT CARLINGFORD COURT NEXT TO KENTUCKY FRIED CHICKEN

THE 5000 SERIES AMPLIFIERS FROM ETI HAVE NO EQUAL

POWER AMP. REF: ETI JAN. MAR. 81

"BLACK MONOLITH"

SPECIFICATIONS

POWER OUTPUT	Around 100W RMS into 8 ohms
FREQUENCY RESPONSE	8Hz to 20kHz, +0 – 0,4dB 2,8Hz to 65kHz, +0 – 3dB Note: these figures are determined soley by passive filters
INPUT SENSITIVITY	1V RMS for 100W output
HUM	– 100dB below full output (flat)
NOISE	–116dB below full output (flat,20kHz bandwidth)
2nd HARMONIC DISTORTION	<0,001% at 1kHz (0,0007% on prototypes) at 100W output using a ±56V supply rated at 4A continuous <0,003% at 10kHz and 100W
3rd HARMONIC DISTORTION	<0,0003% for all frequencies less than 10kHz and all powers below clipping
TOTAL HARMONIC DISTORTION	Determined by 2nd harmonic distortion (see above)
INTERMODULATION DISTORTION	<0,003% at 100W (50Hz and 7kHz mixed 4;1)
STABILITY	Unconditional

In "2001" Arthur C. Clarkes Black Monolith symbolised awesome power – intelligence.
So too do the 5000 "BLACK MONOLITH" Power Mosfet amp kits from Jaycar.
Why would you choose a Jaycar "BLACK MONOLITH" 5000 Power amp over conventional kits? Because you, too are intelligent.
You have seen the specs, and you know that this amp IS the best. You want the best because (whether you know it or not) you are a perfectionist. You won't be conned by cheap and nasty compromises to David Tillbrook's brilliant design. You will want to know if there have been mods to the original design. (There have – and only Jaycar kits reflect them). But let's be specific about the improvements.
– Completely redesigned flagheatsinks for the Driver Transistors. Thoroughly endorsed by David Tillbrook. (The original ones were too small if the bias current was set high for low distortion).
– Ventilation grilles in the covers. These were not included in the original design.
– Blind tapped holes in the exclusive 'Superfinish'® front panel. Heavy gauge screws used for stronger connection of the heatsink bracket to the panel.
– Jig drilled, EXTRUDED, deburred and black anodised heatsink bracket in heavy gauge. All other kits we have seen, a flimsy punched out piece of sheet metal is supplied. Not even anodised!! This is one of the most critical components in the kit.
– Beryllium Oxide heatsink washers supplied. A tube of heatsink compound is also supplied – with enough left over to use elsewhere.
– 'Superfinish'® Front Panel. Despite what others may claim ours is still the best.
– Dual 3 Pin DIN 30V Power Outlets. This extra power outlet enables you to power extra 5000 series components as they arrive on the scene.
– And all of the extra features of our normal Superfinish 5000 amp, like. Metal 1% film resistors, Pre-wound Chokes, Fibreglass PCB's, Heavy Duty Earth Braid, Quality Capacitors, Original Chassis - bar design, Flux shorting straps on transformers etc., etc.
The Jaycar "BLACK MONOLITH" is worth far more than the inferior kits around the market today. That goes without saying.

BUT IT COSTS NO MORE!

That's right. FOR THE MOMENT we are holding our price on this kit to a staggering low $299. We probably won't be able to keep this quality kit below $300 for long.
We all enjoyed '2001' for the first time a long time ago now. You can enjoy your 5000 "BLACK MONOLITH" forever!

ONLY $299– PAY NO MORE!!!

"BLUEPRINT" 5000 PREAMPLIFIER

BLUEPRINT $275

The refinement continues. The silk screen stencil for the front panel is renewed after every run of 25 panels. This ensures the crispest possible lettering. Note that ONLY JAYCAR use the ORIGINAL ETI front panel design. Don't get caught with something you may not like the look of! We use the extra high quality LM394H in the M.C. preamp. and now AT NO EXTRA CHARGE supply gold plated RCA sockets on all inputs, not just the M.C. input.
Despite what others may say, their's is not as good as the original BLUEPRINT Preamp. They do not, for example, get special low capacitance screened cable made to Jaycar specs. just for the preamp. (It's made in Australia, not Taiwan).

AMONG OTHER FEATURES OF THE BLUEPRINT :-

- EXTREMELY CLOSE TRACKING TO RIAA EQUALISATION.
- ENGLISH 'LORLIN' LOW NOISE SELECTOR SWITCHES USED
- LOW NOISE 1% METAL FILM RESTISTORS USED
- TINNED F/GLASS PCB'S
- QUALITY IC SOCKETS PROVIDED
- SPECIAL REAR PANEL
- MULTICOLOURED LED DISPLAY (EASIER TO READ & BETTER LOOKING)
- THERMALLOY HEASINK USED ON REGULATOR

We still have the standard $245 version of this kit which is better than the other $245 kits. We don't sell many though– the BLUEPRINT is better value. 'BLUEPRINT' ONLY $275.

SPECIFICATIONS

Frequency Response	High level input: 15Hz-130kHz,+0,–1dB Low-level input–conforms to RIAA equalisation ±0.2dB (see detail on Phono specs.)
Distortion	1kHz 0,003% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N noise	High-level input, master full, with respect to 300mV input signal at full output(1.2V) 92dB flat; 100dB A-weighted MM input, master full, with respect to full output (1.2V) at 5mV input, 500 ohm source resistance connected 86dB flat 92dB A-weighted MC input, master full, with respect to full output (1.2V) and 290uV input signal 71dB flat 75dB A-weighted

ETI-478MM Moving Magnet input stage

Gain	¼, 1kHz			
Frequency Response	Conforms to RIAA Equalisation ±0.2dB			
Total Harmonic Disorder	0,001%, 1kHz, 10mV RMSinput			
Headroom	28dB with respect to 5mV RMS input signal, i.e. 135mV RMS			
Noise	Total equivalent input noise, 122nV 'A', input shorted, 216nV flat, input shorted			
S/N ratio		1mV	5mV	10mV
	Flat	73dB	87dB	93dB
	A-weighted	78dB	92dB	98dB

ETI-478MC Moving coil input stage

Gain	24
Frequency Response	7Hz - 135kHz+0,–1dB
Total Harmonic Disorder	0,003%, 1kHz, 30mV input
Noise	Total equivalent input noise 83nV flat, input shorted 42nV 'A', input shorted 56nV flat, after RIAA Eq. input shorted 34nV 'A', after RIAA Eq. input shorted

FROM $245

8 CHANNEL MIXER 8002

FROM $495

PRICE BREAKTHROUGH!!!

The Jaycar 8002 Mixer was originally conceived to be the successor to the very popular ETI414 Master Mixer. The 414 was basically configured as a 'stage' mixer and suffered from a number of severe technical limitations – notably poor signal-to-noise figures. Enormous advances in Audio IC's have occurred since the 414 was designed. Jaycar engineers have taken advantage of this. The incredibly low noise and distortion figures of the 8002 are a testimony to the sound basic design of the mixer coupled with the performance capability of these IC's. Whilst the 8002 is the ideal 8 channel compact stage mixer, other applications have been kept in mind.
AS A "STUDIO" MIXER. The prime requirement of a studio mixer is that it must be quiet – i.e. have good S/N. Due to the fact that the "miracle" 5534 IC's are used in the 8002 studio applications are entirely feasible. In addition to this, metal film resistors are used in critical signal areas.
AS A DISCO MIXER. The balanced input feature of the 8002 is not really necessary for disco use. This section can easily be bypassed with either a moving magnet (Dynamic Cartridge) preamp, or a moving coil preamp The sensible format of the 8002 and tremendous equalization facilities should make this mixer popular for disco use.

AS A STAGE MIXER

This is where the 8002 really excels. The 8002 front panel measures 19" wide x 14" high (8 rack units). This enables the 8002 to be mounted into PA equipment racks if necessary. Strickly speaking, the chassis is not needed in this configuration although the chassis is also rack mountable. The 8002 can also console mount with attractive heavy timber end-pieces adding to the appearance of the unit. Powerful "Sends" capability is built into this mixer. Both special effects ('echo' for example) and foldback for the stage performers can be sent FROM ANY ONE OR ALL of the 8 input channels. Fully variable calibrated sends attenuators are provided on each channel. Sends can be panned across the stereo image to create spectacular sonic effects. You could, for example, pan a pre-recorded tape of a steam train rushing from the right hand side of the stage – across – and exit stage left with this facility. Balancing sorts the real mixers out from the toys. With the 8002 you can take either a microphone level input or a line level input into any of the 8 channels. An input selector switch is provided at the top of the mixer panel. Another attenuator is provided at this point to prevent overload of the input circuitry should the incoming signal prove to be higher than normal microphone or line levels Each input channel has 3 band equalization capability with a massive 12dB boost or cut. A pan control enables each input channel to be positioned left thru right across a stereo image. Inputs out of stereo position on a stage can be positioned in the mixer. Finally a quality 60mm slide fade control is provided. We felt that in keeping with the professional nature of this instrument that the extra resolution that the larger control offers is warranted. METERING. The left and right monitor channels have VU metering. Also provided is a 5-band Graphic Equaliser (+/-9dB). An optional LED peak-metering circuit will be available shortly. Master foldback send is also provided.

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Ideas for Experimenters

Programmable wiper controller

This simple circuit uses cheap, readily-available components.

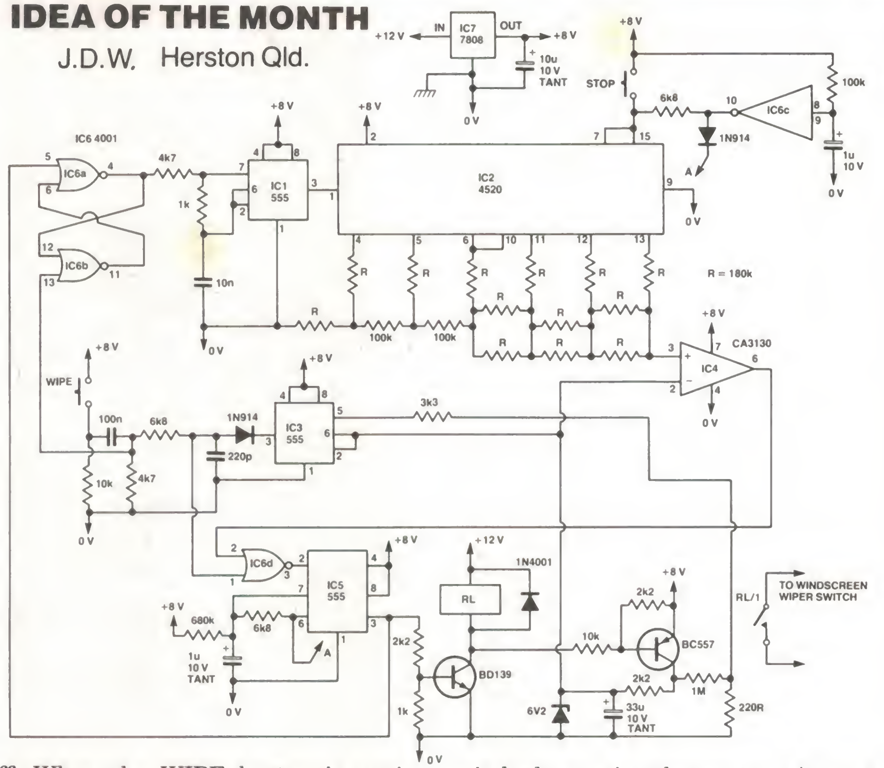
The relay contact is wired in parallel with the standard windscreen wiper switch. A single push of the WIPE button activates the relay for about one second, giving one wipe of the screen. Another push of the WIPE button within 40 seconds of the first will operate the wiper again, which then continues at the interval set by the time between the first and second presses of the WIPE button. The interval is therefore easily programmed by pressing the WIPE button twice, when the screen needs wiping at intervals. If the rainfall increases, the WIPE button is pressed again to set a shorter interval between wipes.

The STOP button may be pressed at any time to stop the wiping. However, if the WIPE button is again pressed within 40 seconds after the last wipe, an interval is again programmed. The last wipe is always remembered as long as it was less than 40 seconds ago. Programming becomes second nature once you've done it once or twice and requires no fiddling.

The circuit operation is as follows: If a wipe has not occurred within the last 40 seconds, pins 6 and 2 of IC3 are below their threshold level, so pin 3 of IC3 is high. When the WIPE button is pressed, pin 2 of IC5 momentarily goes low, allowing the one-second monostable, IC5, to work, activating the relay and the wiper. At the same time, the 33u capacitor is charged up. This discharges slowly after the relay has again turned

IDEA OF THE MONTH

J.D.W. Herston Qld.



off. When the WIPE button is again pressed, within 40 seconds of the first press, pin 3 of IC3 is now low (pins 2 and 6 are above the threshold) so IC6d cannot operate. The flip-flop formed by IC6a/IC6b is switched so that the oscillator formed by IC1 is enabled, thereby causing IC2 to count up, ramping up pin 3 of IC4 until the voltage on it rises to that on pin 2, thereby operating the monostable, IC5, via IC6d. IC6a is also switched, stopping the counter. A count is thus stored in IC2, corresponding to the interval time.

The STOP button resets the counter. IC6 forms a power-on reset circuit.

The circuit was built on a 60 x 67 mm pc board and mounted in a cigarette box-sized case under the dashboard, with the two buttons on the front. The relay was mounted in the engine compartment so it could not be heard.

'IDEA OF THE MONTH' CONTEST

Scope Laboratories, who manufacture and distribute soldering irons and accessory tools, have offered to sponsor a contest with a prize to be given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI. Each month we will be giving away a Scope Panavise pc board holder, model 333 — as described in News Digest, p.8, October '81 issue. Selections will be made at the sole discretion of the editorial staff of ETI Magazine. Apart from the prize, worth about $70, each winner will be paid $10 for the item published. You must submit original ideas of circuits which have not previously been published. You may send as many entries as you wish.

RULES

This contest is open to all persons normally resident in Australia with the exception of members of the staff of Scope Laboratories, Murray Publishing, Offset Alpine, Australian Consolidated Press and/or associated companies.

Closing date for each issue is the last day of the month. Entries received within seven days of that date will be accepted if postmarked prior to and including the date of the last day of the month.

The winning entry will be judged by the Editor of ETI, whose decision will be final. No correspondence can be entered into regarding the decision.

Winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI.

Contestants must enter their names and address where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry.

This contest is invalid in states where local laws prohibit entries.

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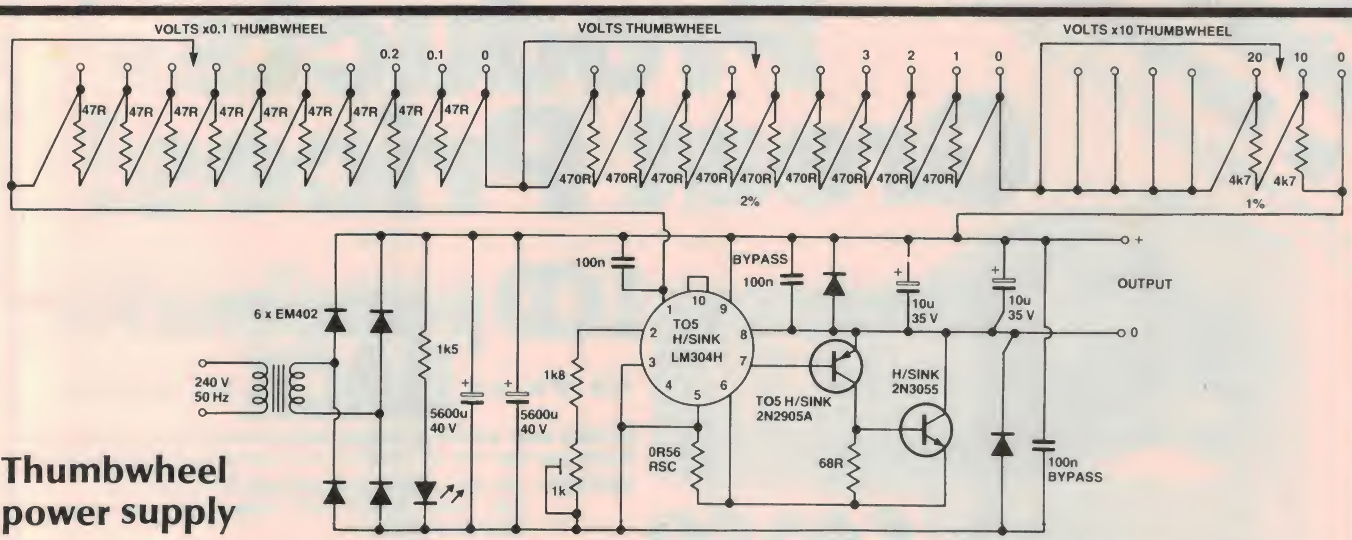
Ideas for Experimenters



Thumbwheel power supply

Most power supplies take time to use because the voltage and current limits have to be set individually. This supply, from **L.W. Brown** of **Burwood, Victoria,** is easy to use, as the current limit is fixed and the voltage is adjusted by dialling the value on thumbwheels.

It is not necessary to have a voltmeter or ammeter on this power supply, although an ammeter could be added in series with the current limit resistor (RSC) to reduce any voltage drop problems. Almost any moving coil movement can be used for the ammeter if RSC is used as the meter shunt and a preset pot in series with the meter is used to set a useful scale value.

Two per cent resistors were used for the unit volts divider, and 1% values for the tens divider. If close tolerance resistors are difficult to obtain, it may be possible to select some from a batch of 5% types with a multimeter. The actual resistance value is not critical, but the ratio of these resistors *is* important. The final voltage adjustment should be achieved with a good multimeter and a near full-scale voltage.

If the decimal thumbwheels are not suitable, an alternative would be a clockface multiturn potentiometer — but these are expensive.

The LM304H is a negative adjustable regulator. Two external transistors increase the output current to over 2 A; output currents of 4 A are possible if transistors with a larger power dissipation and a better than average current gain are used. The maximum input voltage is 40 V, giving a usable output voltage of 0-30 V. This regulator is unusual in that it uses resistor voltage programming. Each additional 500 ohm resistor in series between pin 1 and the positive supply (pin 9) will produce an additional 1 V at the output.

The adjustable resistor between pin 2 and the negative supply provides some trimming, so realistic values of resistors can be used. The resistor RSC sets the current limit. The LM304H has a transistor junction across RSC, and when this conducts the regulator begins to current-limit.

I have provided a table to enable personal customising of the circuit. Some people will need particular voltage ranges; others will only have certain transformers available to optimise the circuit.

My first prototype used three thumbwheels side by side, with individual wiring back to the pc board. The range of the power supply was 0-29.9 V at 3 A. The power transistor (better than a 2N3055) was mounted on a chunky heatsink, in turn mounted on the outside rear of the apparatus. A popular transformer for amplifiers, the M0148, was used, as it is rated at 26-0-26 at 2 A. As this was a centre-tapped winding the two upper diodes were eliminated and the CT connected to the upper positive rail.

A simpler version of the power supply was then constructed, with the output range of 0-19.9 V at 1 A. The output transistor, a 2N3055, was mounted on the pc board with two sheets of 1.5 mm aluminium folded to form a heatsink. One thumbwheel was used for the units and another for the tenths. A slide switch took the place of the tens thumbwheel. The thumbwheels were mounted vertically above each other and mounted flat on the pc board; the only wiring used was the two wires for the output and the power transformer connections.

The one critical component was the output capacitor. I finally used two 10u 35 V tag tantalum caps and a 2u2 greencap in parallel. An unusual feature is that a TO5 top-hat type of heatsink is necessary on both the LM304H and the 2N2905. This heatsink improves power dissipation, but more importantly the reduced temperature improves both voltage and current limit stability. The current limit varies markedly with temperature because of the simple control circuit used in the LM304H.

Table of optional ranges

Voltage Range Vdc	Transformer secondary voltage — Vac	Number of thumbwheels	Actual voltage range
10	12	2	0-9.9
20	18	2+1 switch or 3	0-19.9
30	27	3	0-29.9

Current range — A	RSC ohm	Output transistor type	Number of filter caps	Transformer current — Aac	Heatsink	Diode rating Adc
1	0.56	2N3055	1	1.5	On pcb	1
2	0.33	2N3055	1	3.0	Large — on pcb	1
3	0.22	2N3771	2	4.5	On case rear	3
4	0.15	MJ15003	3	6.0	Large — on case rear	6

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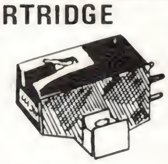

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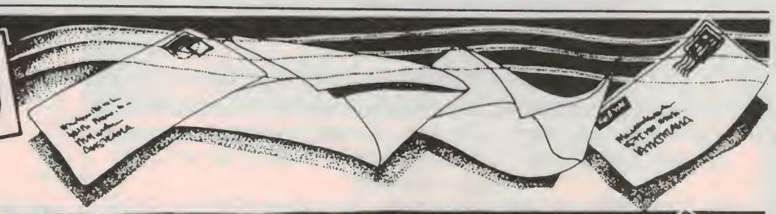

Dear Sir,

I wish to make reference to the recent article entitled 'Circuit Source Guide', as published in your February 1982 issue of ETI. On page 27 there is shown the circuit for a 'Six-bit DAC with 10-bit Precision'. This circuit is based on the well-known (?) R-2R ladder network to provide an analogue representation of the digital input data.

Regretfully, the author appears to have repeated the error which I have found elsewhere. That is, the value of the resistor from the ladder network to ground at the LSB should be '2R' and not 'R' as shown, that is of the value 200k and not 100k as shown. With the value of this resistor as 'R', the analogue output of the DAC produces a seemingly confused mixture of single and double steps, etc, as the input digital signal is varied. When this resistor is correctly valued as '2R' the expected single-bit interval step is obtained, should the output be graphed as the input is run up (or down) over its full range.

This correction to the published circuit has been verified in the practical application of a DAC, but also agrees with information gleaned from a number of sources, including 'Digital Interfacing with an Analogue World', J. Carr, TAB Books. The practical application of this problem relates to my employment, where a commercially produced data transmission system used the R-2R ladder network DAC in both the remote ADC and in the office DAC, so as to produce a control room analogue display of a slowly varying remote analogue condition. The same mistake as described above was repeated in both the ADC and the DAC, and as a consequence the output signal in the control room exhibited a seemingly random display of single and double bit steps on a graphical display as the remote analogue signal was slowly varied in magnitude. Much effort was expended in attempting to discover the cause of this fault, and when all other possibilities were expended the manufacturer's design was closely examined, so revealing the above original design flaw. One wonders how many other systems are about of similar equipment which contain the same mistake, which probably would not be recognised unless the output is displayed on a graphical recorder of sufficient resolution to display the irregular stepping.

Lastly, perhaps your article should more clearly state that the R-2R ladder network requires a BCD digital input to function correctly, although this could probably be deduced from the description of the digital inputs.

I trust that the above information may be of interest to your readers, and should any have built this circuit, that the correction as described will improve the resolution of their system.

G. Clover
Wellington, NZ.

Thank you for pointing this out. We did miss it. As you say this is an error that is repeated in many places — with disastrous effect!

Roger Harrison
Editor, ETI

Dear Sir,

After waiting for some considerable time, I obtained from my newsagent a copy of 'Hobby Electronics Project Book'. Congratulations on an excellent job. From page 6 to 26 it is outstanding.

As an operator of soldering irons and hand tools over a period of more than 50 years, I cannot fault these 20 pages of information and instructions. All the projects are interesting and the reference section extremely handy. When's your next project book coming out?

However we can't be perfect all the time. I'm referring to the two crystal receiver projects, and in particular, to your list of suitable diodes. The 0A202 is not a germanium diode, but a silicon rectifier. It will not perform as well with the low signals encountered in crystal receivers. I tried it, some time ago.

J. Ratcliffe
Southport Qld.

You are quite correct. The OA202 is a silicon diode and, if used, the crystal sets will have less sensitivity than if germanium diodes were employed. I am glad that you enjoyed our Hobby Electronics Project Book otherwise, though.

Roger Harrison
Editor, ETI

Dear Sir,

In the Letters page of the November issue last year you published a reader's letter concerning an electric fence project which you answered in the negative. I think such a project would be very popular, for a number of reasons. Commercially available units tend to be either crude (electromechanical) and not wholly effective, or sophisticated and overpriced. It seems to me that you could design an effective electric fence energiser, perhaps using an ordinary car ignition coil and not a special transformer, that would outperform ready-made ones and cost considerably less.

P. Gosling
Seaham, NSW.

There are two approaches to designing an electric fence energiser: (a) battery-powered and (b) mains-powered. We have looked very closely into both avenues as that letter we published last November has occasioned many readers to write in a similar vein to yourself. Electric fence energisers, or controllers, are covered by Australian Standard 3129-1981, published 1 April 1981 (true!). If you care to fork out $5.80 you will see the requirements an electric fence has to meet. Meeting the principal requirements with regard to output presents problems that are not simply solved yet still result in a device that is effective. The standard says:

12.3 Output Test No 1. The controller shall be connected as for normal operation and a measuring circuit shall be connected across the fence circuit terminals. The measuring circuit shall consist of a calibrated oscillograph, resistors, and capacitors arranged so that the load presented to the controller consists of a resistance adjustable to 500 Ω or to 1 MΩ in parallel with a capacitance variable between 0 and 0.01 μF.

Under these conditions the controller shall comply with the following requirements:

(a) *Peak voltage.* With the resistance of the measuring circuit set to one megohm and the capacitor adjusted to a value to give the maximum voltage output, the peak output voltage shall not exceed 5000 V.

(b) *Output current.* With the resistance of the measuring circuit set to 500Ω, and the capacitor adjusted to give maximum output current, the output current shall not exceed 300 mA for more than 0.3 ms.

(c) *Duration of pulse.* With the measuring circuit adjusted as for paragraph (b) above, the duration of the pulse shall not exceed 0.1 s and the time interval between pulses shall be not less than 0.75 s.

For the purpose of this test, the duration of the pulse shall be taken as the time from the beginning of the pulse until the pulse current has finally decreased to an instantaneous value of 5 mA.

(d) *Current between pulses.* With the measuring circuit adjusted as for paragraph (b) above, the average of the r.m.s. values of current flowing between pulses shall not exceed 0.7 mA.

(e) *Quantity of electricity.* With the measuring circuit adjusted as for paragraph (b) above, the quantity of electricity per pulse, obtained by integrating the area of the current time trace, shall not exceed 2.5 mC for the pulse duration as defined in paragraph (c) above. Where the pulse contains one or more cycles of an alternating current, the area integrated shall include the areas above and below the zero current line.

Experiments with a solid-state pulser and an ignition coil demonstrated to us that such a simple system would not comply with the standard. We could 'ignore' the standard and leave it to constructors and their consciences to see that their units complied but we regard that course as irresponsible. Development is continuing.

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4015	.90
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4018	1.50
4019	.60
4020	1.20
4021	1.10
4022	1.05
4023	.70
4024	1.00
4025	.50
4026	2.20
4027	.60
4028	.90
4029	1.20
4030	.60
4031	2.20
4034	3.00
4035	1.30
4039	.70
4040	1.70
4041	1.05
4042	.70
4043	.70
4044	.70
4046	1.20
4047	1.20
4048	.60
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4050	.60
4051	1.00
4052	.80
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4068	.60
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4070	.50
4071	.60
4072	.50
4073	.60
4075	.60
4076	1.20
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4078	.60
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7410	.40
7411	.40
7412	.40
7413	.50
7414	.70
7416	.50
7417	.60
7420	.40
7421	.40
7423	.50
7425	.45
7426	.40
7427	.40
7430	.40
7432	.40
7437	.40
7438	.50
7440	.50
7441	1.00
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7444	1.20
7445	1.10
7446	1.00
7447	1.00
7448	1.00
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7454	.60
7472	.60
7473	.60
7474	.60
7475	.60
7476	.60
7480	.65
7482	1.80
7483	.80
7485	.80
7486	.60
7489	2.60
7490	.70
7491	.55
7492	.60
7493	.60

7494	.90
7495	.45
7496	.80
7497	2.50
74107	.80
74109	.60
74116	2.20
74121	.45
74122	.65
74123	.60
74125	.55
74126	.60
74132	.80
74141	1.10
74145	.85
74147	2.00
74148	1.40
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74151	.60
74152	4.90
74153	.70
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9310	.65
9311	1.00
9312	1.35
74156	1.50
74157	.60
74161	1.00
74162	1.00
74163	.85
74164	.60
74165	.60
74174	.50
74175	.90
74176	1.10
74177	1.10
74180	.90
74181	2.30
74182	.90
74184	3.75
74185	1.20
74190	1.00
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74195	.65
74196	.85
74197	1.10
74198	1.10
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74221	.90
74290	.90
73293	.90
74365	.80
74366	.80
74367	1.00
74368	1.00
8T96	1.80
9314	1.30
9368	2.50
9370	2.00
74LS SERIES	
74LS00	.40
74LS01	.40
74LS02	.40
74LS03	.40
74LS05	.40
74LS08	.40
74LS09	.40
74LS10	.40
74LS11	.40
74LS13	.50
74LS14	.90
74LS15	.40
74LS20	.40
74LS21	.40
74LS22	.40
74LS26	.40
74LS28	.40
74LS30	.40
74LS32	.40
74LS33	.40
74LS37	.50
74LS38	.50

74LS40	.50
74LS42	.75
74LS47	.85
74LS48	1.00
74LS49	1.00
74LS51	.40
74LS54	.50
74LS55	.55
74LS58	.65
74LS73	.55
74LS74	.60
74LS75	.45
74LS76	.50
74LS78	.50
74LS83	1.00
74LS85	1.00
74LS86	.50
74LS90	.70
74LS92	.90
74LS93	.80
74LS95	.65
74LS96	1.55
74LS107	.60
74LS109	.60
74LS112	.60
74LS113	.65
74LS114	.50
74LS122	.50
74LS123	.75
74LS125	.50
74LS126	.70
74LS132	.80
74LS133	.50
74LS136	.50
74LS138	.80
74LS139	.85
74LS151	.75
74LS153	.60
74LS154	1.50
74LS155	1.00
74LS156	1.00
74LS157	.90
74LS158	.70
74LS160	.85
74LS161	.85
74LS162	1.00
74LS163	.85
74LS164	1.30
74LS165	.50
74LS168	1.90
74LS169	1.90
74LS170	2.80
74LS173	.90
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74LS181	2.50
74LS189	3.80
74LS190	1.30
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74LS221	2.10
74LS245	2.35
74LS247	.90
74LS249	1.30
74LS251	.80
74LS253	.80
74LS257	.65
74LS258	.50
74LS259	2.45
74LS260	.90
74LS266	.90
74LS273	1.60
74LS279	.65
74LS283	1.15
74LS290	1.10
74LS293	1.15
74LS295	1.60
74LS298	1.00
74LS352	1.30
74LS353	1.30
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2N2904	.45
2N2905	.40
2N2906	.45
2N2913	1.20
PN2907	.60
2N3053	.60
2N3054	1.90
2N3055	.90
2N3301	.40
2N3440	1.10
2N3502	.70
2N3503	.70
2N3563	.30
2N3564	.30
2N3569	.30
PN3565	.30
PN3566	.30
PN3567	.30
2N3568	.30
2N3638	.30
2N3639	.30
2N3640	.30
2N3641	.30
2N3645	.30
PN3642	.30
PN3643	.30
PN3644	.30
2N3646	.30
2N3692	.50
2N3693	.35
2N3702	.30
PN3694	.30
2N3704	.30
2N3709	.30
2N3713	2.20
2N3819	.80
2N3866	2.00
2N3904	.30
2N3906	.30
2N4030	1.10
2N4032	.90
2N4033	.90
2N4036	1.00
2N4037	.90
PN4121	.30
2N4233	1.60
2N4235	1.90
2N4236	2.20
2N4248	.30
PN4249	.30
2N4250	.30
2N4258	.30
2N4292	.70
2N4354	.30
2N4355	.30
2N4356	.30
2N4398	5.00
2N4401	.50
2N4402	.50
2N4403	.50
2N4416	1.00
2N4906	2.80
PN4868	.30
2N5088	.30
2N5089	.30
2N5179	1.90
2N5303	3.30
2N5320	.80
2N5401	.30
2N5458	.70
2N5459	.70
2N5461	.70
2N5484	.70
2N5485	.70
2N5486	.70
2N5769	.30
2N5770	.25
2N5830	.25
2N5831	.30
2N5856	.30
2N5873	1.10

2N5874	1.40
2N5961	.30
2N5963	1.10
2N6027	.60
3N201	1.50
AC127	1.00
AC128	1.00
AC187	1.00
AC188	1.00
AD149	3.10
AD161	2.00
AD162	2.00
BC318	.30
BC319	.18
BC327	.15
BC328	.30
BC337	.30
BC338	.30
BC547	.15
BC548	.15
BC549	.15
BC549C	.40
BC557	.16
BC558	.16
BC559	.16
BC637	.60
BC638	.60
BC639	.40
BC640	.40
BCY70	.85
BCY71	.85
BD115	1.50
BD135	.70
BD136	.70
BD137	.70
BD138	.70
BD139	.70
BD140	.70
BD235	.65
BD234	.50
BD237	.50
BD262	1.20
BD301	.75
BD302	.75
BD263	1.25
BD435	.75
BD646	1.70
BD647	1.80
BD675	.80
BDV64B	4.50
BDV65B	4.50
BF115	.50
BF173	.70
BF180	.70
BF195	.30
BF198	.30
BF199	.30
BF336	.80
BF337	.80
BF458	.90
BF494	.40
BFX85	.75
BFY50	.90
BFY90	1.30
BSV17	1.00
BU126	3.00
BU208	3.00
BUX80	7.90
FT2955	1.40
FT3055	.75
MEL12	.90
BU326A	3.40
MJ2955	1.00
MJ4032	7.40
MJ802	3.30
MJ4035	6.90
MJ4502	3.70
MJE340	1.20
MJE350	1.70
MJE295	1.90
MJE8055	1.90
MJE3521	.60
MJ15003	5.00
MJ15004	5.00
QF102	.60
MPF131	1.40
MPSA05	.60
MPSA06	.60
MPSA12	.60
MPSA14	.60
MPSA42	.60
MPSA56	.80
MPSA92	.60
MRF475	4.40
TT31B	.90
TI3PIC	1.00
TIP32B	.90

TIP32C	1.00
TIP33A	1.10
TIP34A	1.20
TIP42B	1.50
TIP42B	1.10
TIP110	1.30
TIP120	.90
TIP2955	1.90
TIP3055	1.90
VN88AF	3.90
MICRO CHIPS	
ADCO 800	15.00
DACO 080	3.90
2102 650 NS	1.40
2111	8.60
2513	14.50
2516	55.00
2532	12.00
2650	23.00
2708	4.50
2716	4.90
4116	1.90
5101	9.00
MM5307	18.00
MM5309	6.50
MM5312	9.00
MM5369	2.60
5387	8.50
MM5395	6.50
6502	10.50
6508	5.50
6520	5.50
6522	10.00
6532	17.00
6551	17.00
MC6900P	9.00
MC6802	13.60
MC6808	12.50
6810A	4.90
6820	5.50
6821	6.00
6850	5.15
6852	6.40
7106	12.60
7107	15.00
7210	13.20
Z80 CPU	14.00
Z80A CPU	16.00
Z80 P10	13.80
Z80A P10	16.50
Z80 CTC	13.80
Z80A CTC	16.50
Z80 DMA	20.00
Z80 S10/0	19.00
Z80 S10/1	56.90
Z80 S10/2	56.90
Z80A S10/0	63.00
Z80A S10/1	63.00
Z80A S10/2	63.00
8035	27.00
INS8050	15.00
INS8080	8.00
P8085	25.00
8155	22.00
8165	22.00
8205	5.00
P8212	4.00
8214	8.00
8216	5.90
8224N	5.50
8224	7.50
8226	5.90
8228	9.50
8238	8.00
8243	8.00
8251	14.00
INS8251	6.50
8253	19.50
8255A	8.60
8257	19.00
8259	15.00
8275	41.00
8279	11.00

8295	25.00
Ay-5-2376	19.56
8748A	29.00
8755A	45.00
MCT2	.80
MCT6	3.30
MCT275	1.50
MCC671	3.00
4N28	.85
4N33	1.20
4N26	.85
MM80C95	.90
80C96	.90
MM80C97	.90
8098	.90
OPTOCOUPLERS	
MCT2	1.00
MCT6	3.30
MC275	1.50
MCC671	3.00
4N28	1.00
4N33	1.20
4N26	1.00
VOLTAGE REGULATORS	
78L05	.50
LM341P-5	.80
7805	1.00
7905	1.70
LM309K	1.95
7805K	2.10
LM323-K	6.90
78H05KC	8.50
78L12CP	.50
79L12	.90
LM341P12	.75
7812	1.00
7912	1.90
7812KC	2.15
7912KC	2.60
79H12KC	8.00
78L15	.50
79L15	.90
LM341P15	.80
7815	1.00
7915CT	1.80
7915KC	2.60
78H15KC	6.50
78L18	.50
7818	1.40
78L24	.50
79L24	.90
7824	1.10
LM371T	2.40
LM337T	3.80
LM317K	4.50
LM337K	5.90
LM350K	8.40
78HGKC	10.50
78P05	16.50
BRIDGES	
VM48	1.50
W02	.60
W04	.60
KHPC02	2.00
KBP602	2.50
KBP604	2.60
KBP606	2.80
KHPC1002	2.60
KBPC1004	3.20
KBPC1006	3.20
MDA3501	4.20
MDA3502	4.20
MDA3504	4.50
DISPLAYS	
MAN2A	6.30
MAN72A	2.20
MAN74A	2.20
MAN52A	3.40
MAN82A	3.40
MAN84A	3.40
MAN6740	3.60
MAN8610	3.30
MAN8640	3.30
TIL306	12.00
DL704	2.20
DL707	2.30
DL747	3.40
DL750	4.00
FND357	1.80
FND500	1.80
FND507	1.80

ETI 9/82/5

TO ORDER: Heavy items sent Comet Freight on. Mail Order phone 481-1436. Wholesale Customers phone: RITRONICS WHOLESALE 489-7099.
Mail Orders to P.O. 235 Northcote 3070 Minimum P&P $2. Add extra for heavy items, registration and certified mail.
Prices. spec. subject to change without notice.

Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project — check with our advertisers if it is not mentioned here.

ETI-647 'Turtle Talk' speech synthesiser

This project is being distributed as a kit, wholesale, by Flexible Systems. To date, Rod Irving Electronics, All Electronic Components and Electronic Agencies have indicated they will be stocking the kit. If you're after a kit, contact one of these firms, not Flexible Systems.

ETI-918 'Photophone'

This little light beam transceiver is amazingly effective — in daylight or in dark! Suppliers who have indicated they'll be stocking this as a kit are — Altronics in Perth, All Electronic Components and Rod Irving Electronics in Melbourne and Dick Smith stores. If you've got most of the parts in your junk box, you'll probably be trying to hunt up a solar cell and the electret mic insert. Solar cells are stocked by: Tandy — who have two suitable types, 276-124 which is 25 x 50 mm, and the 276-125 which is 50 x 50 mm; Dick Smith stocks a circular segment type, catalogue number Z-4835, and Jaycar currently stock some small ones — two circular types, 30 and 45 mm in diameter, plus a rectangular type measuring 12 x 25 mm.

Electret microphone inserts are widely stocked. Tandy have one, catalogue number 270-092. Electronic Agencies have one, catalogue number CE0162 and Dick Smith stocks one, catalogue number C-1160. Jaycar also have a suitable insert.

Printed circuit boards will be available from the suppliers listed in last month's Shoparound. All the other components are off-the-shelf items and you should have no difficulty getting them.

ETI-1509 dc-dc inverter

The only specialised components used in this inverter are the two transformer cores. The feedback transformer uses the FX2242 potcore, which is widely available. The output transformer uses the Philips EC-core assembly, specified in last month's 12 V Fluorescent Light Inverter (ETI-1505). This assembly should be readily available this month, although you'd better get in early because both the Fluorescent Light Inverter and this project are likely to be quite popular and supplies might diminish quite rapidly.

LOCALLY-MADE INSTRUMENT CASE

A smart new instrument case, model I/C-1, moulded in ABS plastic has been released by Cadin/Clift Electronics P/L. The case features rounded edges and has provision internally for a variety of pc board mounting positions for both the top and bottom covers. Internal slots also provide for recessed front and/or rear panels.

It comes complete with pc board mounting hardware, self-adhesive rubber feet and blank 'easy cut' styrene front and rear panels. The case measures 132 x 129 x 38 mm and is ideally suited for small instrumentation applications, housing projects, prototypes etc.

All enquiries to Cadin/Clift Electronics, Melbourne. (03)288-6244, (03)870-0684.

★ **NEW STORE opening October in Carlingford** ★

AT CARLINGFORD COURT NEXT TO KENTUCKY FRIED CHICKEN

1/3 OCTAVE 28 BAND EQUALISER

The 2801 is a single channel graphic equaliser that divides the audio spectrum into twenty eight one third octave bands. Each frequency segment is controlled by a slider that provides up to — 10dB of adjustment in standard ISO steps. The 2801 was designed primarily to compensate for any deficiencies in the linearity of speaker systems, acoustic peculiarities of the hall or listening room, and inadequacies of program source quality.

In P.A. application the equaliser may be used to improve sound quality and increase intelligibility by attenuating problem frequencies that cause ringing, boominess or other disruptive resonances that occur in acoustically difficult rooms. The 2801 allows sound systems to be "tuned" according to the special acoustics of a room, to maximize output and minimize feedback.

As a creative tool in sound recording or re-recording the 2801 allows complete freedom in contouring response over the complete audio spectrum from 31.5Hz to 16KHz.

SPECIFICATIONS

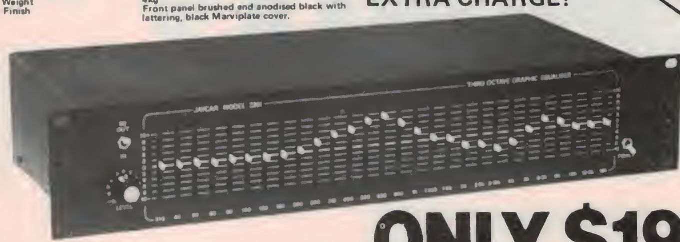
OISTORTION (@ 2 volts out)	Less than .04% 20Hz–20kHz
FREQUENCY RESPONSE	
–EO. OUT	Flat
–EO. IN	20Hz–20kHz±½dB
SIGNAL TO NOISE RATIO (@ 2 volts out, controls flat)	Greater than 85dB
OUTPUT IMPEDANCE	50k to 100k depending on the input configuration
MAXIMUM INPUT VOLTAGE	10 volts
EO centre frequencies	31.5, 40, 50, 63, 80, 100, 120, 160, 200, 250, 315 400, 500, 630, 800, 1K, 1.25K, 1.6K, 2K, 2.5K, 3.15K, 4K, 5K, 6.3K, 8K, 10K, 12.5K, 16K, Hz
Renga of controls	
Individual Filters	±10dB
Leval	±15dB
CONTROLS	
EQUALISATION	28 Vertical potentiometers continuously variable ±10dB
LEVEL	Rotary potentiometer variable ±15dB
EQ. BYPASS	Toggle switch
POWER	Toggle switch
Terminations	Rear panel RCA sockets and 6.5mm sockets for input and output
PHYSICAL	
Size	19" x 3½" x 8" (standard rack mount size)
Weight	4kg
Finish	Front panel brushed and anodised black with lettering, black Marviplate cover.

NEW ALL I.C. SOCKETS AT NO EXTRA CHARGE!

TOTALLY REFURBISHED MODEL—2801 MKII A

This model is distinct from the 2801, 2801 MK II. It features quality I.C. sockets for all I.C.'s as well as several component changes. ie: We are using 4136 op amps again because they draw less current than the TLO75/85. This results in less hum radiation from the transformer. We are also using higher value slide pots, and a 5534 op amp for the line driver. Using the 5534 renders the output short circuit proof-handy whenon the road.

You get all these great new features at no extra cost!



ONLY $198

NEW MkII model A

JAYCAR 2010 EQUALISER

The 2010 is a two channel graphic equaliser featuring ten adjustable controls on octave centre frequencies (independent for each channel). Each control provides up to ± 14dB of adjustment. Each channel is also equipped with a level match control giving an overall gain of adjustment of ± 14dB. The functional versatility of the 2010 equaliser is unsurpassed. Eight modes of operation are available from the push button switches on the front panel. Included amoungst these are the ability to equalise both recording and playback when dubbing tapes. The 2010 has been designed to be compatible with all commercially available equipment and is ideal for use in a Hi Fi system or PA system

SPECIFICATIONS

ELECTRICAL (EACH CHANNEL)	
FREQUENCY RESPONSE	
F.O. LINE OR TAPE	±0.5dB 10Hz to 20kHz, Controls flat
EQ BYPASS	Flat
SIGNAL TO NOISE RATIO 2 VOLTS OUT CONTROLS FLAT	Greater than 87dB
TOTAL HARMONIC OISTORTION 1 VOLTS OUT CONTROLS FLAT	Less than .04 % 20Hz to 20kHz
OUTPUT IMPEDANCE	100ohms
RATED OUTPUT	2 Volts RMS into 10K load
OUTPUT AT CLIPPING	10 volts RMS
INPUT IMPEDANCE	50K nominal
MAXIMUM INPUT VOLTAGE	10 volts RMS
EO CENTRE FREQUENCIES	31, 62, 125, 500, 1K, 2K, 4K, 8K, Hz±10%
RANGE OF CONTROLS	
INDIVIDUAL FILTERS	±12 dB at Centre Frequency
LEVEL MATCH	±10dB
CONTROLS	
EQUALISATION	10 Vertical Slide Controls for each channel
LEVEL	Vertical Slide Control each Channel
EO BYPASS	Pushbutton Switch
EQ LINE	Pushbutton Switch
EO TAPE	Pushbutton Switch
MONITOR TAPE	Pushbutton Switch
POWER	Pushbutton Switch withLED Indicator
TERMINATIONS	Rear panel RCA sockets for both input and output connections
PHYSICAL	
DIMENSIONS	483mm x 89mm x 152mm (19"x 3½"x 8")
WEIGHT	4kg
FINISH	Front panel brushed and anodised Aluminium silk screened lettering. Black Marviplate covers.

ONLY $129

NEW MkII model A with QUAD-FETs

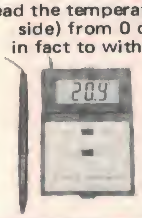
EXCLUSIVE!!! ALL JAYCAR TEST EQUIPMENT KITS ARE PROVIDED WITH QUALITY I.C. SOCKETS AT NO EXTRA CHARGE!!!

Digital EA2/82 Thermometer

Ref: EA Feb 1982

Read the temperature in your room (or outside) from 0 degrees C to 100 degrees C in fact to with in 0,1 degree C. Fantastic resolution on a bright easy-to-read display.

INC CASE

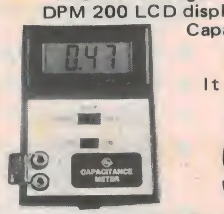


$69

DIGITAL CAPACITANCE METER

Ref: EA March 1982

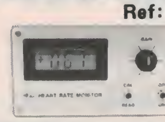
This kit once again uses the amazing DPM 200 LCD display/driver module Capable of measuring capacitance from 1pF to 19.99uF. It is a must in every workshop or lab. Kit includes case.



$69

HEART RATE MONITOR

Ref: EA 7/82

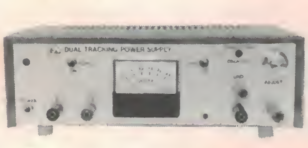


NOW $69

WAS $79 SAVE $10

This unit enables you to measure your own pulse instantly and accurately. It is light enough even for joggers to carry. A must for people who may have heart problems.
Complete kit including LCD Display.

EA dual tracking P/S



EXCLUSIVE!! US–MADE 10 TURN .25% LINEARITY POT used for greater accuracy

$84.50

Ref: EA March '82

1% resistors used NOT 2%.

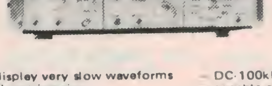
At last!! A dual-tracking power supply with fixed +5V reg. at a reasonable price!!

YOU PAY NO MORE FOR A QUALITY JAYCAR KIT!!

Digital Storage CRO Adaptor

Ref: Feb 1982 EA

Not only can you avoid buying an expensive CRO but you can have the features of the REALLY expensive ones!!!



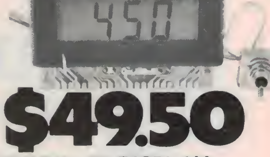
$110

- Can display very slow waveforms
- One shot triggering
- Inbuilt graticle shows on TV screen
- Crystal locked timebase
- DC-100kHz bandwidth
- capable of storage operation

Staggering value at $110.

NEW!!! LCD TACHO KIT!

ref: EA May 1982



$49.50

- USES NEW DPM–05 DISPLAY
- FITS INTO YOUR DASHBOARD
- RPM, DWELL DISPLAY

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$5 $9.99 ($1.20) $10-$24.99 ($2.40)
$25 $49.99 ($3.50) $50-$99.99 ($4.60)
$100 up ($6.20)

NEW SHOP HOURS
Mon Fri 8.30 to 5.30pm
Sat 8.30 to 12.00pm
Thurs night to 8.30pm

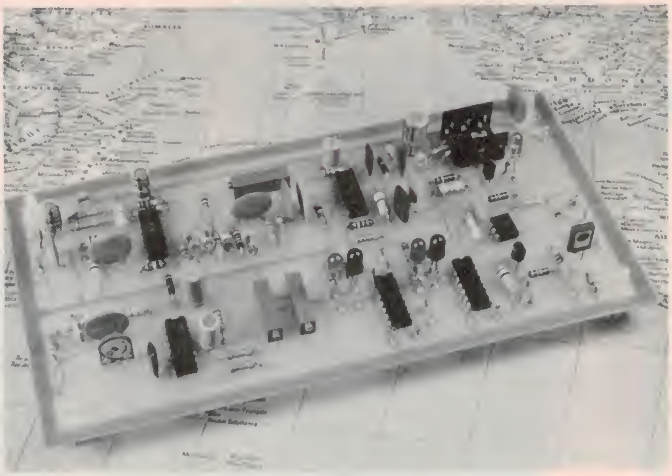
Russian amateur satellite in trouble

The Russian amateur satellite, Iskra 2, the first satellite to be launched from a manned spacecraft (reported in this column in the July issue), experienced trouble with its 15m to 10m transponder soon after launch.

Iskra 2 was placed in orbit on May 17th when two cosmonauts, Anotoly Berezovdy and Valentin Lebedev pushed the satellite out of an air lock on their Salyut 7 space station. The satellite carried the first HF to HF transponder ever orbited.

It entered an elliptical orbit, 355 km at apogee, 240 km at perigee, placing it well within the ionosphere. The orbit shrinks at about 1 km a day. About a week after launch, the transponder was reported to be not functioning.

Transponder problems were put down to either de-sensitisation or feedback as the input and output shared the one antenna. However, the 29.578 MHz beacon is functioning well and has been reported to be heard for as much as an hour after the satellite has passed over the horizon. (Item courtesy Westlink Report.)



AMSAT satellite computer net

Specifications for AMSAT's international computer network, to be called AMICON, are being prepared by Hank Magnuski, K6AM.

The network will operate over a transponder on board the Phase IIIB satellite now expected to be in orbit in the next month or so. The AMRAD group is also preparing its own recommendation. (From Westlink Report.)

SSB above 300 MHz 'out of the question'?

An article in a recent New Scientist on frequency congestion would have us believe that SSB above 300 MHz is "... out of the question".

There are some amateurs who would disagree. Totally. Like Dick Norman VK2BDN, current holder of the world distance record on 1296 MHz — a contact established using SSB.

The article concerned, 'Why Radio is Running Out of Airwaves', by Barry Fox, discussed various aspects of spectrum congestion in Britain. On SSB and its use on VHF, he says, "At first, engineers could make SSB operate with enough stability only up to 30 MHz. Now, with modern circuits, the threshold has been raised to 300 MHz, and SSB mobile radio could work in the VHF bands".

"But SSB in the UHF bands ... is still out of the question."

Admittedly, he's probably taking the commercial case where fixed channels are used and the stability requirement is greater than amateurs use. But, out of the question? — hardly.

Amateurs lead the way again.

'Sinadder' from Vicom

Products manufactured by the Helper Instruments Company are now available from Vicom International. These products include the famous 'Sinadder 3'.

The unit features an automatic distortion meter which includes an internal 1 kHz generator or monitor. It measures SINAD sensitivity and gives rapid alignment.

The units ac voltmeter provides nine ranges from 10 mV full scale to 100 volts full scale.

It can be used to check audio circuits from microphone to loudspeaker levels. An internal audio amplifier and loudspeaker controlled by the range switch and front panel pot maintains proper sound level regardless of input.

It can also be used as an audio signal tracer.

Details from Vicom, 57 City Rd, South Melbourne Vic. 3205. (03) 62-6931.

Compact RTTY terminal

Designed for HF and VHF amateur radio and/or commercial use at baud rates of 45 to 50 with a shift of 170 Hz, the MDK-17 RTTY terminal is now available from GFS Electronic Imports.

Other baud rates and shifts may be accommodated but some component changes are necessary.

The MDK-17's design makes for simple hook-up to both transceiver, teletype and/or computer terminal. Its 10 ports provide for all combinations of TTL and high voltage 20-60 mA send-receive systems. An open collector output allows direct keying of HF Transceivers.

State-of-the-art circuitry is used throughout its design, according to the makers, including the XR2211 IC which combines both limiter and active band pass filter in the one package.

The tone generator uses an XR2206 IC which allows for excellent temperature stability, they say. Accurate setting of tone frequencies and demodulator centre frequency is provided for by using 15-turn trimpots in these critical areas.

Other features include the provision to invert the signal sense in both the send and/or receive modes. LEDs are used to indicate transmitted tone and correct receiver tuning. An auto-start output is available for driving TTL circuitry. Only a single +12 V supply is required as the power source.

The MDK-17 is available fully assembled, aligned and tested for $145 plus $5 post or as a complete kit at $95 plus $5 post. The kit is supplied with comprehensive, easy to follow assembly instructions. Approximately two hours is required to assemble and test it.

For further information contact GFS Electronic Imports, 15 McKeon Road, Mitcham Vic. 3132.

Miniature X-Y 'scope

Vicom International now represent Vu-Data Corporation of the United States, who have just released a mini X-Y display scope, Model 2010.

The unit can be employed as a stand-alone unit, or mounted in a system panel, and its manufacturers claim that it is ideal for numerous applications previously satisfied only by large and expensive display modules.

This model is claimed to have excellent trace resolution, CRT brightness, and high frequency capabilities. Vertical axis bandwidth is 10 MHz, while horizontal X-axis bandwidth is 5 MHz, according to the specs.

Contact Vicom, 57 City Rd, South Melbourne Vic. 3205. (03)62-6931.

NEW STORE opening October in Carlingford

AT CARLINGFORD COURT NEXT TO KENTUCKY FRIED CHICKEN

CAR COMPUTER KIT

THIS GREAT NEW EA DESIGN IS AVAILABLE FROM JAYCAR!!!

FROM $109.50

SAVE A FORTUNE ON PETROL BILLS!

—YOU WILL KNOW EXACTLY HOW MUCH FUEL YOU ARE USING AND THE RATE AT WHICH IT IS BEING USED!!!

CALCULATES

- FUEL ECONOMY (INSTANTLY AS YOU TRAVEL ALONG) IN LITRES/100KM.
- AVERAGE ECONOMY OVER A TRIP.
- AMOUNT OF FUEL USED SO FAR
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- ELAPSED TIME
- SPEED IN K'S/HR. MORE ACCURATE THAN CAR SPEEDO
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The MPF-I Microprofessor features a Z80 microprocessor — the most widely used 8-bit processor, and the basic unit comes as a single board computer complete with 36-key keyboard, a 6-digit display, 2K of RAM, 2K monitor ROM, cassette interface (for storing programs on an ordinary audio cassette tape), 24 input/output lines for expansion (expansion units are available) and a speaker for sound output. It's all powered by a plug pack.

Special manuals are provided aimed at helping you teach yourself by experiment using the Microprofessor.

Amazingly, it sports a tiny BASIC interpretor in a PROM you can plug in. Commands include continue, call, for . . . next, goto, gosub, input, if . . . then, let, list, load, new, print, return, run, save, stop. You get a form of mnemonic readout on the display.

Expansion units include a speech synthesiser and a printer.

The SSB-MPF Speech Synthesiser Board features:

- TI speech synthesis chip.
- 4K EPROM for time-clock program and speech utility.
- Two EPROM sockets for expanding vocabulary.
- Uses keyboard and speaker of MPF-I as input/output device.
- Adjustable voice pitch and volume.
- 9 V, 0.5A adaptor provided.
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The PRT-MPF Printer features:

- Compact thermal printer.
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- 9 V, 0.6A adaptor provided.

Rules: This contest is open to all persons normally resident in Australia with the exception of members of the staff of Emona Enterprises, Murray Publishers, Offset Alpine, Australian Consolidated Press and/or associated companies. Closing date for the contest is the 31st October 1982. Entries received within seven days of that date will be accepted if postmarked prior to and including 31st October, 1982. The winning entry will be drawn by the editor of Electronics Today International, whose decision will be final. No correspondence can be entered into regarding the decision. Winner will be advised by telegram the same day the result is declared. The name of the winner and the winning answer will be published in the next possible issue of Electronics Today International. Contestants must enter their names and addresses where indicated on each entry form. Photostats or clearly written copies will be accepted but if sending copies you must cut out and include with each entry the month and page number from the bottom of the page of the contest. In other words you can send in multiple entries but you will need extra copies of the magazine so that you send an original page number with each entry. This contest is invalid in states where local laws prohibit entries. Entrants must sign the declaration, accompanying this contest, that they have read the above rules and agree to abide by their conditions.

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In 100 words or less tell us why you want the Microprofessor and what features attract you.

It's that easy, but hurry entries close 31st October 1982.

COMPUTING TODAY

Zilog release 'virtual memory' processors

The Z8003 and Z8004 Virtual Memory Processor Units (VMPUs) just released by Zilog, are 16-bit MOS microprocessors offering all the features of their Z8001/2 CPUs, plus integral provisions for operation in a virtual-memory environment.

The Z8003 VMPU generates 23-bit addresses organized into 128 segments of up to 64 Kbytes each. The 8004 VMPU generates 16-bit addresses.

Both are designed to implement a 'virtual memory' environment where programs and data being operated on need not reside simultaneously in main memory.

The benefits or virtual memory are the elimination of main memory size constraints on application programs, with an associated increase in programmer productivity and lower system costs because smaller memory sizes can support large applications.

In such an environment, provision must be made for retrieving parts of the program or data located in 'secondary' storage (e.g: a disk). When the CPU attempts to access such 'non-resident' data, the transaction accessing that data must be interrupted, the state of the CPU saved, the desired data moved to main memory, the state of the CPU restored, and the interrupted instruction restarted.

The Z8003 has an external abort pin that permits interruption of instruction execution before completion of the instruction.

Ideal for use in shared-memory and multiple-microprocessor systems, the Z8003/4 features an interlock status signal that prevents memory access collisions by arbitrating attempted simultaneous accesses to shared resources, Zilog say.

The Z8003/4 VMPUs are designed to work with present and future Zilog memory management units (MMUs), including the Z8015 Paged MMU, which will be available later. This flexibility allows segmented or paged virtual memory systems to be implemented.

Production quantities will be available in the fourth quarter of 1982, Zilog say.

X.25 test and development system

The Tekelec TE92 data monitor and test system is capable of handling speeds up to 128 Kbps and operates as either an analyser or simulator in the X.25 environment.

The TE92 monitors traffic and selected data is captured in dynamic RAM (16 Kbytes) or on diskette (80 Kbytes), and presented to the operator as a time-correlated split screen display at the frame and packet level for easy analysis — either in interpreted X.25 mnemonics, in ASCII, EBC Dic, Hex or Binary.

Various data capture triggers are available which allow even specific logical channels within multiplexed traffic to be traced.

As a simultor, the TE92 emulates an X.25 network or a subscriber to that network and correctly handles all X.25 data transfer and error recovery procedures.

Also available is 'Sitrex', an exclusive scenario simulation package, which enables the user to customise applications software, and to introduce deviations from X.25 standards.

The applications of the TE92 are:-

- Network monitoring, maintenance, diagnostic testing, fault detection
- Equipment/software development, testing, certification
- Deviations to X.25 standards, customising protocol
- Protocol analysis, training in X.25 protocol

Tekelex Airtronic is represented in Australia by Paton Electrical Pty Ltd, 90 Victoria Street, Ashfield NSW 2131.

Motorola to alternate-source Intel bubble memory products

An agreement to cross-license and alternate-source magnetic bubble memory technology has been announced by Motorola Inc and Intel Corporation, of Santa Clara, California.

Under terms of the agreement, the companies will jointly develop two new one-megabit devices based on the architecture of Intel's existing 7110 one-megabit bubble memory.

The new bubble memories will be smaller versions of the present 7110.

The first device will have the same performance as the present 7110, while the second will provide half the access time and twice the data rate (200 kilobits/s).

Intel and Motorola also will jointly adopt a low-height, leaded package for the new memory. The package is presently under development by Intel and is similar to one currently manufactured at Motorola.

Additionally, to provide complete component-level interchangeability to users, Intel will transfer Motorola design and compatibility data to allow Motorola to produce the peripheral chips necessary to operate the new bubble memories.

These support circuits include Intel's 7220 bubble memory controller, 7230 current pulse generator, and 7242 formatter/sense amplifier. Motorola will manufacture and alternate-source each of these and any other products required for the two new one-megabit memories.

The cross-licensing agreement also calls for Motorola to provide Intel with a process technology for bubble memory device production.

Customer shipments of the first new bubble memory are expected to begin in the second quarter of 1983, with the higher performance device available by the end of that year.

The agreement reached by the two leading microprocessor manufacturers is expected to accelerate the growth of the bubble memory market. Users' systems design and production activities will be enhanced by the availability of a standardised bubble memory component architecture.

The Graphics Magician

The Graphics Magician is available for Apple II 48K with Applesoft and a disk drive, by Penguin Software; review by Phil Cohen.

The graphics capabilities of the Apple are well known, and it is quite possible to make use of the sophisticated plotting routines directly from BASIC with no additional software.

This is all very well for routine applications, such as the plotting of graphs, histograms, etc, but when it comes to the clever stuff like games animation, it takes quite a bit of effort to make the machine perform.

For example, to make objects on the Apple's screen 'move' you have to get into the machine code 'shape tables' and other mysteries. None of this makes animation very easy.

However, Penguin Software (of Illinois, USA), has produced a series of programs that take all the effort out of animation, and provide a good deal of other nice features, too.

What you get for your money is a plastic bag containing a small 32-page manual and a single 5¼" floppy disk. The floppy contains all the software you need, and (unlike many such packages these days) is not 'copy-protected'.

It has become standard practice for software publishers to 'copy-protect' their disks, making them very difficult to copy — the idea being to cut down on copyright infringement. However, this means that even a bona fide user can't make 'back-up' copies in case of accidents!

This has led to the ludicrous situation of companies producing 'lock-picking' software to get round the 'copy-protection' software of other companies' disks, and selling this 'lock-picking' software to potential buyers of package software — not to enable them to infringe copyright, but just to allow them to make back-up copies for their own security and peace of mind!

However, Penguin Software have (very wisely) chosen not to copy-protect this package — although they have included a strongly-worded warning in the manual against buyers selling unlicensed copies.

Files

The disk contains a large number of files, most of them in 'binary' format. However, the boot-up file (named HELLO, by Apple convention) that is executed when you start the system up with the disk in place, will automatically put onto the screen a full 'menu' of all of the software available — including some very impressive demonstrations.

The package is completely 'menu-driven', so that whenever you are finished with a particular piece of software, exiting will get you back to the menu so that you can choose the next part of the package that you want to use.

The package is in three sections. The first allows you to create 'shapes' (although not using the Apple shape table concept), 'paths' (which are what the shape will move through), and 'objects' (which are a combination of a shape and a path.

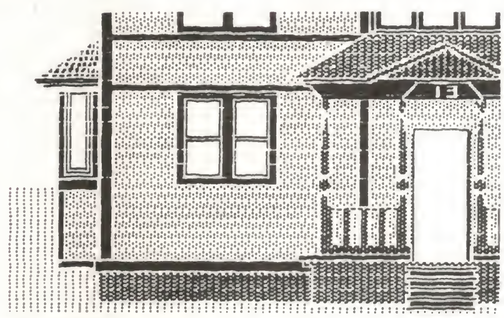
This part of the package will allow you to have the figure of a man running from one side of the screen to the other, with the leg movement included! Each 'shape' is defined in seven 'steps' — each step is actually the same shape slightly altered. As the shape moves across the screen, each of the parts in turn is used automatically, giving the impression that the figure is, for example, 'running'.

The 'path' along which the shape moves is variable, too — you can choose any path you like, and can even have a number of shapes 'chasing' each other along the same path, or one shape moving along different paths under program control.

All sections of the Graphics Magician package give complete control (within the limitations of the machine) over colour.

The second section of the package is for drawing pictures. These might be used as a background for the shapes in the course of the game, for example. The inset on this page shows the standard that can be achieved.

A 'brush' can be moved across the screen using the 'paddle' controls (standard with the Apple II). This 'brush' can draw lines, 'paint' in different textures and colours, and even 'fill' areas of the picture automatically — the brush is positioned in an area which is bounded by lines, and a single command causes the area to be filled with a particular colour and texture.



The last section is a sophisticated means of generating Apple 'shape tables', which allow various shapes to be put onto the screen under program control with varying scales, positions and rotations.

. . . and how is all this used? Well, the whole package is designed so that the results (whether animations, pictures or shape tables) can be used with stand-alone BASIC or machine code programs developed by the user.

The picture-drawing section has one last trick in this respect — instead of storing the picture as an image of what's on the screen, it is stored in terms of the steps you went through to draw it. What this means is that the picture will take up very much less room, so that literally hundreds of pictures can be stored on one disk.

Manual

One very important part of any such package is the manual that comes with it. The manual for the Graphic Magician is adequate — and when I say 'adequate', please bear in mind that this puts it streets ahead of most of the packages on the market!

Documentation is often thought of as an 'add-on', but in situations like these it becomes almost as important as the software itself. The documentation with this package was enough to allow me to operate it with little effort.

On the whole, I think the package would be invaluable to the adventure freak ('adventure' is a class of computer game that tries to model fantasy situations) — the ability to store all those pictures on one disk is ideal for that (and the manual points this out, too).

Another possible use is for those involved in educational computing. The use of pictures (sophisticated enough to be used as textbook drawings) could allow whole textbooks to be put onto a disk for 'programmed' learning in the true sense.

And then of course there is the indisputable prime use for all domestic computers — for fun. I'm sure that, even if you had never written a computer game, having this package close at hand would convince you to do so!

The Graphics Magician is distributed by Imagineering, 22 Sir John Young Crescent, Woolloomooloo NSW 2011, and is available through many Apple dealers and computer speciality stores.

16-bit professional microcomputer

A new low cost computer for business has been introduced by Barson Computers Pty Ltd (formerly known as CMC) of Melbourne.

Known as Sirius 1, this personal computer has a 16-bit Intel 8088 microprocessor. Standard memory is 128 Kbytes RAM expandable up to 896 Kbytes.

Two 5¼" (133.35 mm for us) floppy disks give a storage capacity of 2 x 600 Kbytes, formatted, in the single sided version. An optional double-sided, double-density extension brings the storage capacity up to 2 x 1.2 Mbytes.

This multi-language computer accepts BASIC, Fortran, Pascal, PL/1 and PL/M.

Sirius 1 is equipped with one parallel and two serial ports. The parallel port is programmable to be compatible with most currently available printers. The two serial ports are also programmable to be used in synchronous or asynchronous modes.

Sirius 1 operates under CP/M86 from Digital Research and MS/DOS from Microsoft. Most programs written under CP/M can easily be recompiled to run on Sirius 1.

Sirius 1 can display charts, graphs and half-tone pictures. A voice synthesiser gives Sirius the power of speech.

Barson Computers are at P.O. Box 1675, Nth Sydney NSW 2060. (02)90-7833.

Peripheral input/output device

The Fairchild F3871 Peripheral Input/Output (PIO) device provides two 8-bit I/O ports, external interrupt, and a programmable timer. An 8-bit wide bi-directional data bus transfers I/O data bytes between the F3870 Central Processing Unit and the PIO.

The PIO is used in systems that require the I/O capability and interrupt functions of the F3851 PSU, but do not need the ROM storage of the PSU. The PIO is pin-compatible with the PSU.

The F3871 has the same improved timer and ready strobe output as the F3870 CPU; therefore, for software compatiblity with the F3870, the F3871 PIO should be used in the F8 multichip configurations.

For further information contact Fairchild Australia Pty Ltd, 366 Whitehorse Rd, Nunawading Vic. 3131. (03)877-5444.

APPLE II 'LOGO' LANGUAGE

Logo started out as a language for large computers, but under the direction of Dr. Seymour Papert, its creator, it was developed into a language for Apple microcomputers, requiring an Apple II or Apple II plus with 64K RAM.

Apple Logo is said to make explicit many of the fundamental ideas of programming, as well as encouraging good programming habits and providing powerful language processing, making word-oriented programs as easy to write as numeric ones. Its commands are not complicated and it doesn't require a knowledge of higher mathematics, making it suitable for computer students of all ages, including young schoolchildren.

Turtle graphics is one of Apple Logo's key features. Simple, literal commands control a 'turtle' cursor that draws on a high-resolution video screen. Apple Logo is interactive, executing commands instantly, and users acquire programming skills by instructing the turtle to generate shapes and designs. For example, the commands 'forward 30 right 90' direct the turtle to draw a line 30 steps long and then make a 90° right turn. By typing the instruction four times, the student programs the computer to draw a box; the series of instructions can then be saved as a single procedure, and the drawing may be quickly incorporated into more complex designs. In this way complex programming is divided, as in many other structured high-level languages, into small, manageable pieces.

Apple Logo is extensible, enabling users to extend the built-in operations of the language by defining and saving new procedures and commands. It also features recursion — which allows a procedure to call itself — as well as list processing and error and file handling. Such features make the Apple II with Logo suitable even for college and university use.

Apple Logo is available now from Electronic Concepts, 55-57 Wentworth Ave, Sydney NSW 2000, Apple Computer Inc's sole authorised Australian distributor. Contact them on (02)212-2833 for further information.

New functions for EXORset

A major redesign has converted the Motorola EXORset from a low-cost software development system to a self-contained combined hardware-software development systems, without any increase in price.

This redesign, the EXORset DS35, now offers an alternative solution to more expensive, complex modular hardware development systems or multi-user timesharing systems, Motorola claim.

A feature of the EXORset DS35 is its ability to operate emulators which connect directly into the user's target system. An opening in the top cover above the card cage allows the appropriate emulation board(s) to be inserted.

Emulators will be available for the MC6805 families of NMOS and CMOS micro-control units. In addition, other compatible EXORbus boards, such as PROM programmers or Micromodules, may be easily inserted into the card cage.

The EXORset DS35 has fully populated 56K RAM, plus an additional card slot.

The EXORset DS35 memory map is defined by a PROM, allowing the user to reconfigure the architecture of the system. Four EXORciser/ Micromodule compatible connectors are available for the disk controller and three additional modules such as input/output or any of the other compatible Motorola modules.

The memory map, EXORbug monitor, and XDOS operating system are compatible with the EXORciser, allowing program portability between different development systems. A configurable RS-422/433 or RS-232C serial interface is provided for interconnection to an external system.

EXORset DS35 is based on the new generation MC6809 8-bit external/16-bit internal microprocessor.

In addition to BASIC-M Pascal is also available for the EXORset DS35 system.

Intel unveils 16-bit 'CPU board on a chip'

Intel Corporation has released a single chip containing a 16-bit CPU and all of the other functions commonly found in a single-board CPU subsystem.

Designated the 80186 it can take the place of 15 to 20 individual ICs and offer a lower-cost, higher-performance solution for cost-sensitive applications such as personal computers, word processors, small business computers and intelligent terminals, Intel say.

Its applications range includes distributed processing nodes and input/output (I/O) subsystems.

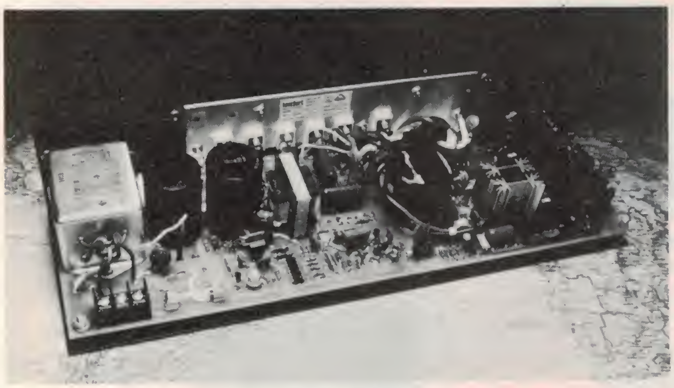
Because of its high degree of functional integration, it is less expensive to design and produce a system using the iAPX 186 than with other 16-bit microprocessors, say Intel.

It takes up less board space, is priced lower than the sum of the parts it replaces, is compatible with all existing 8086 and 8088 software and eliminates the ordering, testing, inserting and inventory costs associated with the replaced chips. It has twice the performance of a standard 5 MHz 8086.

"The 80186 will radically change the economics of building high-volume, 16-bit microcomputer systems," said Jeff Miller, marketing manager of Intel's Microcprocessor Operation. "For the first time, all microprocessor designers will be able to afford 16-bit performance."

According to Miller, while the 8086 was introduced at $115 each for 100-piece quantities in 1978, the 80186, which integrates an enhanced 8086, plus 15 to 20 support chips on one piece of silicon, will be a $30 product in volume its first year in production.

Designers building new systems can take advantage of advanced CPU features and 10 powerful new instructions. They will also be able to use all of the third-party software now available for the 8086 and 8088. Engineers who want to upgrade existing 8086 or 8088 designs can preserve their software investment and selectively streamline portions of it using the new instructions. Thus, both first-time users and those experienced with the iAPX 86 family will have a lower system cost solution and a much shorter design cycle, say Intel.



Switching supply with VDE certification

Amtex Electronics has released the Boschert XL200-4501 switching power supply which has received the German VDE certification. According to the manufacturer this is the first American-made open frame switcher which has received such certification.

The certification is with respect to safety (VDE 0730) as well as electrical noise (VDE 0871/N12). These VDE specifications are similar to Telecom Australia's requirements, e.g: 3500 V isolation and 6 mm separation for mains tracks on the pcb.

Since the unit is user adjustable for 95 — 132 or 190 — 264 Vac, it is suitable for operation anywhere in the world.

The XL200-4501 is intended for general purpose use in medium power data and office processing systems, e.g: word processors, intelligent terminals, small business computers, microprocessor systems with CRT displays and peripheral motors for printers and disks. It provides up to 200 W of total power on four outputs: a main rail of 5 V at 20 A, ±12 V at 4 A each, and −5 V at 3 A.

Price of these units in one-off quantities is $530 plus sales tax. Delivery is from stock. Also available from stock is the OL152-4001 switching supply designed for the Diablo 1300 series printers. Outputs are +5 V at 15 A and ±12 V at 4 A each.

Enquiries to Amtex, P.O. Box 285, Chatswood NSW 2067. (02) 411-1323.

Intel move

Intel Australia Pty Ltd, a wholly-owned subsidiary of Intel Corporation of the USA, is expanding its operations and has moved to larger premises at the Spectrum Building, 200 Pacific Highway, Crows Nest.

The telephone and telex numbers will remain unchanged, namely (02)436-2744 and AA20097.

The move marks the beginning of Intel's expansion in Australia.

ARCNET local network interface chip to be sold on open market

Datapoint Corporation has announced that the integrated circuits used to interface workstations to a Datapoint ARCNET local network will be made available to the public through Standard Microsystems Corporation of Hauppauge, New York.

Datapoint and Standard Microsystems have signed an agreement under which Standard Microsystems was granted a non-exclusive license to market Datapoint's RIM (Resource Interface Module) chip and the associated ARCNET transceiver chip. Together, the two chips provide the electronics necessary for ARCNET interfacing.

It was announced in September 1981, that the interface chips would be used by Tandy Corporation to interface Radio Shack TRS-80 Model II computers, creating a Radio Shack implementation of the ARCNET local network.

"When we initially made the chip set available to Tandy, we decided to deal with any other interested vendors on a one-by-one basis," noted Victor D. Poor, Datapoint's Executive Vice President for Research and Development.

"Since the announcement we have received many enquiries from vendors who want information about the chips."

"This agreement with Standard Microsystems will make the chip set publicly available and at the same time relieve Datapoint of having to deal in the semiconductor business — something we don't want to do," Poor said.

Enquiries to Datapoint Corporation Australia, 157 Walker St, North Sydney NSW 2060. (02)922-3100.

Intro to the micro

A new book from the Hayden stable, 'An Introduction to Microprocessors: Experiments in Digital Technology' by Noel T. Smith, landed on the Editor's desk recently and it would seem a good choice for the 'practical' student of digital logic and 6800 microprocessor systems.

The book starts with a swift introduction/revision of solid state devices and integrated circuits, plus some advice on 'breadboarding', as the book encourages the reader to actually try out the circuits and techniques illustrated.

Chapters two to six then cover logic gates, synchronising circuits, clocked logic, data manipulation and display and data processing — the latter covering the basics of microprocessing, built around the Motorola MC14500B. Experiments are given all along the way, reinforcing the learning process by practice. CMOS and TTL logic are covered.

Chapter seven covers multibit microprocessors, specifically the 6802 and system components — PIA, ACIA and memory. The rear of the book contains a useful array of data sheets and device pinouts. In general, the treatment is thorough, well organised and clearly written — a book well worth a close look if you're just getting into digital logic and microprocessing. 178 pages, 278 x 217 mm, soft cover. Available from Butterworths, P.O. Box 345, North Ryde NSW 2113. (02)887-3444.

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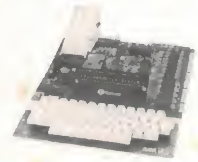

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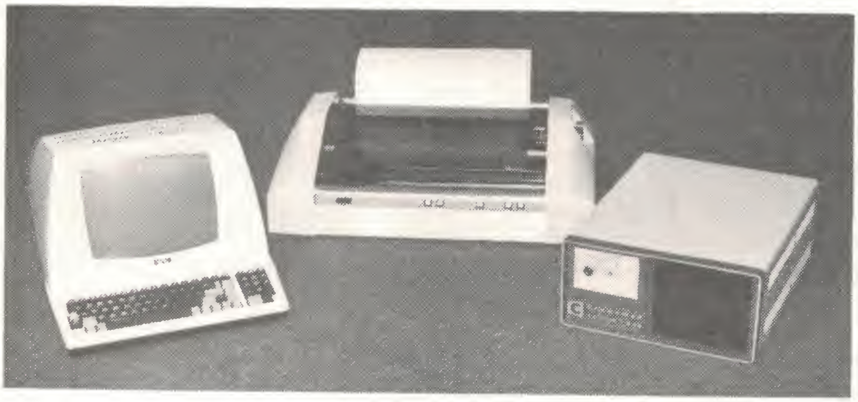

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Independent Apple software

Eight new, independently-developed software programs are being offered by Apple computer.

Independently developed software programs are selected for publication by Apple's software evaluation group. The new selections comply with Apple's requirements for user-friendly, quality programs.

Comm-pac is a data communications program that enables an Apple II to communicate with other computers, time-sharing systems, networks, newswires, and other subscription services.

Paralax is a collection of graphics utilities which lets the user develop and manipulate high-resolution shapes for Applesoft BASIC programs.

Designer's Toolkit is a program for the Apple II that computerises the drafting table. Emulating pen, pencil, and brush on paper, Designer's Toolkit and the Apple Graphics Tablet let the user generate graphics for mapping, architecture, and drafting.

Magic Spells is a learning game that transforms the memorisation of spelling lists into an adventure complete with castles, treasures, demons, and a sage wizard.

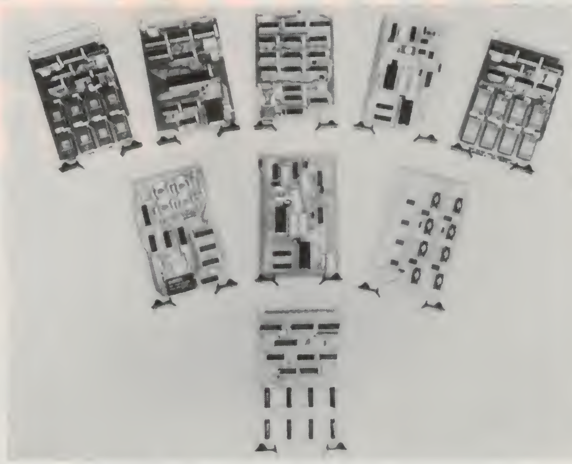
Math Strategy and Spelling Strategy are two innovative programs that teach youngsters how to use the mind's eye to sharpen math and spelling skills.

Moptown is a collection of entertaining and interesting logic games for children. Self-paced learning of reasoning skills is reinforced through the use of sound and colorful 'Moppet' characters.

Speed reader is a complete reading development course designed to double and even triple reading speed while increasing comprehension.

These and other independently developed software programs published by Apple are listed in the 1982 Special Delivery Software (SDS) catalogue.

To submit programs for evaluation by Apple, write to Software Evaluation, 2025 Mariani Ave, Cupertino CA 95014.



Thorn-EMI Eurocards

Thorn-EMI has appointed Rank Electronics as its Australian distributor of the Thorn-EMI Eurocard range of microprocessor modules.

Looking to expand their available range of application hardware, Rank Electronics seized the opportunity to distribute the South Australian designed and manufactured product. The Thorn-EMI Eurocard offers users low cost, high reliability and compatibility with a number of independent vendor supplied racking and packaging systems.

For further information contact your local Rank Electronics sales office, or Rank Electronics, 19 Trent Street, Burwood Vic. 3125. (03) 29-3724.

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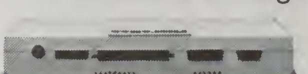

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Versatile speech synthesiser

This speech synthesiser, originally designed for the Tasman Turtle robot (see ETI, April/May/June '82), is an extremely versatile unit with functions and features offered in no other speech synthesiser system. Applications range from a talking doorbell, to a communications aid for the handicapped, from a self-learning tool to an industrial equipment voice indicator. Or whatever you dream up.

Allan Branch
Flexible Systems, Hobart, Tasmania

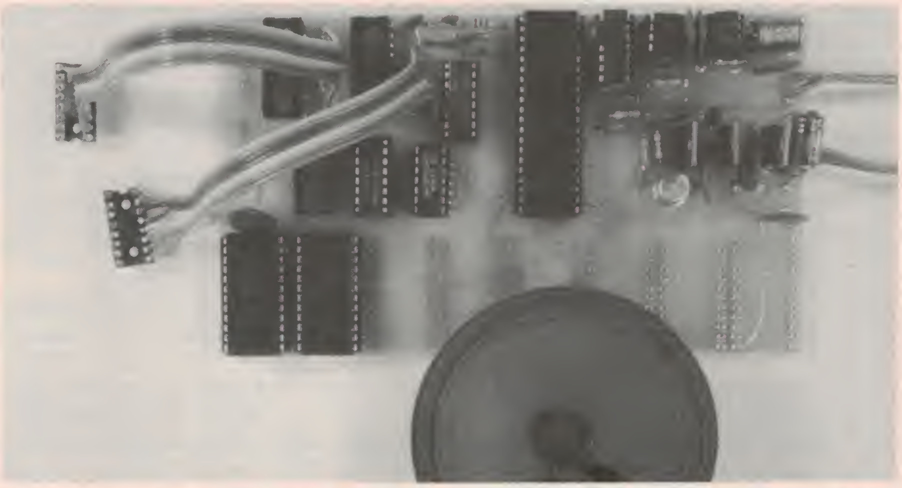
THERE ARE MANY speech synthesisers about now. In the last few years a number of companies have produced specialised integrated circuits or IC sets designed to produce speech, electronically, in various ways. The result is a maze of talking electronics — clocks, cars, ovens, calculators, alarms and learning aids to name a few. Just what led up to this modern electronic wonder?

For some time, psychologists and artificial intelligence researchers have been developing a careful understanding of the human speech communication mechanism. The ultimate aim, as could be expected, is to develop machines that can listen, understand, answer back or ask questions and then carry out an appropriate task.

The problem has always been the *enormous* amount of data or information stored in even very short utterances. Electronic memory has not yet reached the stage where unlimited 'words' can be stored and recalled at will.

That is not to say that the data cannot be recorded at all. Mankind has been coding verbal speech in various ways and storing the coded information, so that it is available for decoding relatively easily, for thousands of years! Some of these techniques are not usually realised for what they are since they are a part of every day life and a major activity in communication.

The types of encoding and decoding used so that the speech data can be stored varies in these old techniques. The most common is the use of written symbols such as hieroglyphics, alphabet characters, shorthand symbols or pictures. Speech synthesis in this case goes under the common name of 'reading'. The trouble is that man is still the instrument needed to do the coding (writing) and then the decoding (reading).



The speech synthesiser uses National Semiconductor's Digitalker chip set on a board just 155 x 90 mm.

Recording or storage

The first cylinder recording and playback machines were the start of the electronic version of speech coding and eventual synthesis. The speech data were stored, and still are, as a code of displacement values from a reference line on a physical medium such as plastic or metal. A machine does the coding (disc-cutting lathe) and a machine (record player) does the synthesis on decoding. The playing back can be done when and in what order the user requires. It is normally done by a human who selects the record, the track and the time of playback (synthesis) although it can be done by machine (a jukebox). Tape recordings are another example.

The ease with which these types of equipment work and their abundance in western society obscure a very important fact. The information content or number of bits of information stored is *colossal.* A lay person would tend to think of a unit of information as being a sentence or a word or a letter. This is not so.

Sampling

Sampling theory dictates that a sampling rate of at least twice the maximum frequency to be reproduced is necessary to record and playback an analogue signal by taking 'samples' of that signal. Imagine a voice with a highest frequency of 1000 Hz (normal female speech). A sample rate of at least 2000 Hz is required. For an analogue device such as a microphone or record stylus, this means the physical equipment has to have a response of *at least* 2000 Hz (i.e: be able to vibrate that quickly).

Now each single sample bit (analogue) has a particular value, say between 1 and 256. A binary number having eight bits would be necessary to represent each value. Therefore *one second of speech* would require the equivalent of approximately *two kilobytes* of memory or storage information. This is about half a track at the start of an LP record or a couple of 2114 memory IC chips.

A total of *20 minutes of speech,* therefore, occupies some 20 x 60 x 2000 bytes ▶

or *2.4 megabytes* of memory, the equivalent of some 36 microcomputers having 64K of RAM!

Alternatively, this occupies one side of a normal LP record, and LP records have frequencies greater than 1000 Hz.

Not yet convinced? Twenty minutes of speech is recorded in about 20 pages of a paperback book, so a 200 page book, which is not a large book, holds ten times as much again — 24 megabytes!

Redundancy

Language, written or spoken, is a remarkable thing. Despite its apparent efficiency in storage capacity, it contains a considerable amount of redundant information. Try this as an example: get a friend to write out a sentence in pencil on a single line. Then have them rub out the bottom half of the sentence. Now you try and read it. Providing your 'friend' hasn't used some strange Gaelic expressions or something similar, you'll find that you can decipher the sentence — with a little difficulty perhaps. This is a crude example because both essential and redundant information is removed but you can see that you *can* synthesise the original sentence *even though 50% has been removed.* If the right redundant bits are removed, the sentence can be reduced even further than that and yet still be restored through synthesis, and probably with greater speed and accuracy.

The same can be done with speech using digital electronics. By removing the redundancies and with appropriate sampling, speech patterns can be 'compressed' and stored for later synthesis into what we recognise as speech.

There are three techniques currently used to achieve this extraction or compression of data and they are based on different ways of looking at the speech waveform.

If one looks at a speech waveform on an instrument such as an oscilloscope then a waveform like the one below is seen:

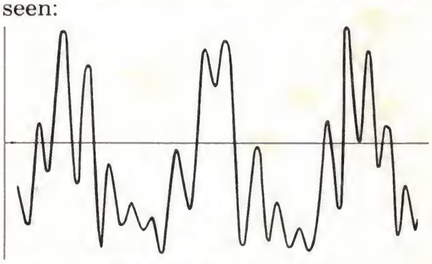


Figure 1. **Typical waveform.**

If the amplitude of the waveform is recorded for consecutive periods of time then the speech data has been *coded* and if the code is read back so that the original amplitude variation can be regenerated, then the speech is *synthesised.* The technique is called *waveform digitisation.*

A second technique is called *phoneme reconstruction.* The work done in the last 50 years or so in the fields of linguistics and acoustics have revealed 'subunits' of human speech. These have various names like phonemes, formants, glottals, nasals, stops, fricatives, morphemes, trills, laterals etc. These can be put together in reasonably complicated ways to form sounds. These parts or subunits can be seen in special recordings called spectrographs.

The alphabet was a bad early attempt to distinguish these parts of sounds and give them names. We use about 160 different types in English speech. Someone only came up with 26 when the alphabet was developed. That is why we have multiple letter sounds such as ch, ng, ough, ea, oo, sh, etc.

It is possible to get by with only 40 if you don't mind 'mechanical' speech. A piece of speech written with this sort of data should look something like:

" ðə 'lɪŋgwɪst 'sɔ: ðə pèlɪkən# "

Figure 2.

It becomes relatively easy to synthesise speech from these subunits since only a small number of sound subunits have to be stored and each word can be generated by recalling which phonemes to use and what order to use them in. This uses less memory than the waveform digitising mentioned earlier. A data rate of about 400 bits per second will suffice. The problem is what symbols to use when specifying various phonemes. A conventional typewriter or computer keyboard runs out after 26.

A more sophisticated (but not yet more satisfying) method approaches the problem from a completely different viewpoint. In fact, this method was one of the earliest attempted in the young days of acoustics. It models the human vocal tract and is called (by some people) *linear predictive coding.* A 'noise' generator, either mechanical (tubes and wind pump) or electronic (an oscillator or oscillators), is used and various things are done to the noise to copy the things that we do when we cause speech to occur.

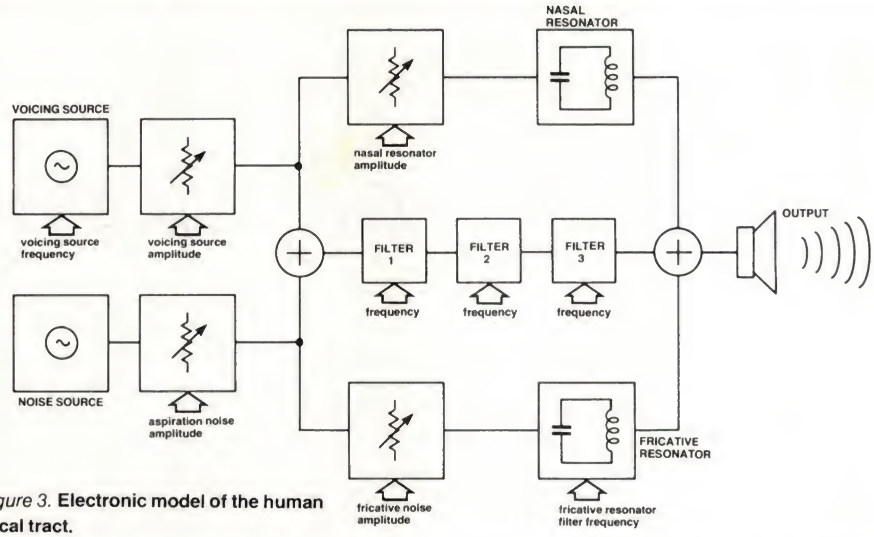


Figure 3. **Electronic model of the human vocal tract.**

An electronic model of the vocal tract is shown in Figure 3. When we speak we do various things at different times with different parts of the vocal tract. These variables include things like alter the diameter of the pharynx at set places, block the nasal cavity, raise or lower the tongue, oppose lips and teeth, stretch vocal cords, close the glottis, etc.

With synthesis, the variables are identified for each sound to be coded and only information about these actions are stored in memory. When recalled, these variables tell the mechanical or electronic equipment what to do as it generates noise. With luck, the noise sounds like speech. The memory requirements are about five times that of the phoneme reconstruction technique.

The three major techniques of speech synthesis — waveform digitisation, phoneme reconstruction and linear predictive coding, are employed in digital electronic speech synthesisers produced by specialist IC manufacturers. Each produces a chip or chip set capable of producing clearly recognisable words, sounds and phrases. There are limitations in the 'vocabulary' each produces and the quality of the sound generated, but having heard the result one cannot help being amazed. The companies involved are National Semiconductor, Texas Instruments and Votrax. The technique employed and chips or chip set are as follows:

Waveform digitisation
National's DT1050 Digitalker
Phoneme reconstruction
Votrax's SC-01
Linear predictive coding
TI's TMS-5100 'speak 'n spell'

ETI-647 'TURTLE TALK' SPEECH SYNTHESISER BOARD

- Mounts in 'Tasman Turtle Robot' (ETI-645 — April/May/June '82)
- Can be used as 'stand-alone' speech synthesiser
- Can interface to almost any computer
- Produces fixed words using simple program
- Can say alphabet and numbers
- 109-word minimum vocabulary, plus prefixes, suffixes, tones
- Vocabulary expandable to about 600 words (up to 8 ROMs)
- Words can be spelled
- Different languages available (mixture permitted)
- Different voices (male, female, child) possible
- Sounds other than speech can be used
- Phrases, sentences easily programmed
- World exclusive 'mute' facility to create other words, etc
- Clock oscillator on-board
- Audio amp. on-board
- Voltage regulators on-board
- ROM power saver circuit

An excellent discussion on the three techniques, well worth reading, was published in the November 1981 issue of *Practical Computing* (p. 112-114).

Turtle Talk

Inevitably, a speech synthesiser system must be a conglomeration of compromises between storage capacity, data rate, speech quality and cost. The higher the data rate, the better the speech quality. When setting out to select a system to add speech to the Tasman Turtle Robot (see ETI, April/May/June '82) we looked for a system that gave compromise between data rate and speech quality. The National Digitalker system was selected. It applies a series of data compression techniques to remove as much as possible of the data not absolutely necessary. Word and sound reconstruction is done by a complex algorithm, but the Digitalker, we thought, provided the best quality available and still required only modest memory space.

A number of extra functions, plus interfacing, were designed into the Turtle Talk Board using the Digitalker so that an extremely powerful speech synthesis board results. The extra functions include a 'ROM power saving' circuit and a 'mute' facility that permits other words to be constructed from the standard vocabulary words. This feature is a *world first* and the subject of a patent application. The features of the ETI-647 'Turtle Talk' Speech Synthesiser are summarised in the accompanying panel.

The design

An overall block diagram of the speech synthesiser board is shown in Figure 4. From this you can see that the system is virtually self-contained. The only necessary external inputs required to produce speech are 13.8 Vdc power (or 12 Vdc) and data in. The latter can be provided from a set of switches, from discrete logic or from a microprocessor or microcomputer. All necessary interfacing and decoding is done on-board as well as power regulation and audio filtering and processing.

In all, 12 ICs are incorporated, although not all of them may be required, depending on the way you interface the synthesiser to the 'outside world'. Up to eight 'speech' ROMs can be included on-board, although only the 'basic' two will be provided with kits. These provide a total of 144 'words'. This includes 109 'real' words, the 26 letters of the alphabet (ay, bee, see, dee . . .), the numbers one to twenty plus 'thirty', 'forty', 'fifty', 'sixty', 'seventy', 'eighty', 'ninety', 'hundred', 'thousand', 'million' and 'zero'. Also included are the word prefixes 'centi', 'milli' and 're', as well as the suffix 'ss' for making plurals. Two tones and five 'silence' periods make up the remaining 'words'.

More speech ROMs can be added if a larger vocabulary or a foreign language is required.

A block diagram of the National Semiconductor speech processor chip used in this project is shown in Figure 5. This IC, designated MM54104, uses the waveform digitisation technique discussed earlier.

Word selection input (SW1 — 8) is held in a register. This is multiplexed with data from the speech ROMs (DATA 1 — 8). From this, two digital control signals emerge — a 'control word address' and a 'phoneme address'. These are held in two registers and multiplexed onto the speech ROM address buss (ADR 0 - 13). 'Control words' from the ROM (via the ROM data input) are held in a 'control word register', passing to the 'control logic' which accepts 'chip select' (CS), 'command select' (CMS) and 'write' (WR) inputs for overall control of the IC, and also puts out an 'interrupt' (INTR) signal for communication back to the equipment sending input to the chip.

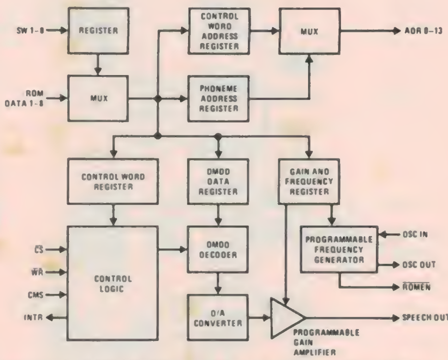


Figure 5. **Internal block diagram of the Digitalker speech processor chip.**

The frequency and amplitude information of speech phonemes (word subunits) are reassembled by the speech processor chip from binary data fetched from the ROMs at the appropriate time. The encoded amplitude information is passed to 'deltamodulation decoder' (the DMOD DECODER block) which drives a digital-to-analogue converter (the D/A CONVERTER block). This changes the digital amplitude information to partial amplitude information which passes through a programmable gain amplifer. The encoded gain and frequency information is held in a 'gain and frequency register'. This selects frequency information from the programmable frequency generator and sets the gain of the programmable amplifier. The resultant is speech or whatever sound is programmed. ▶

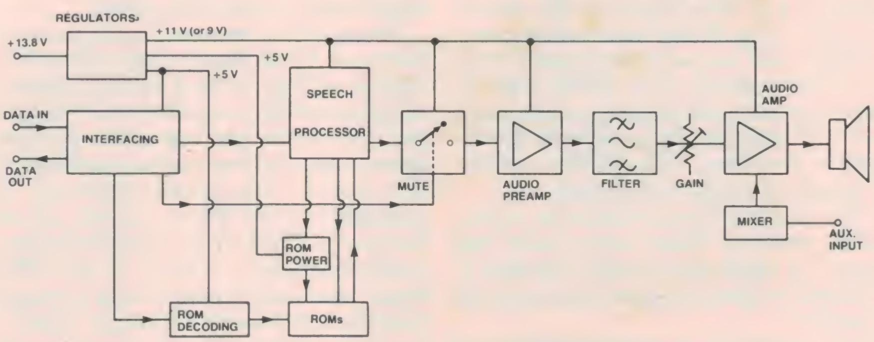
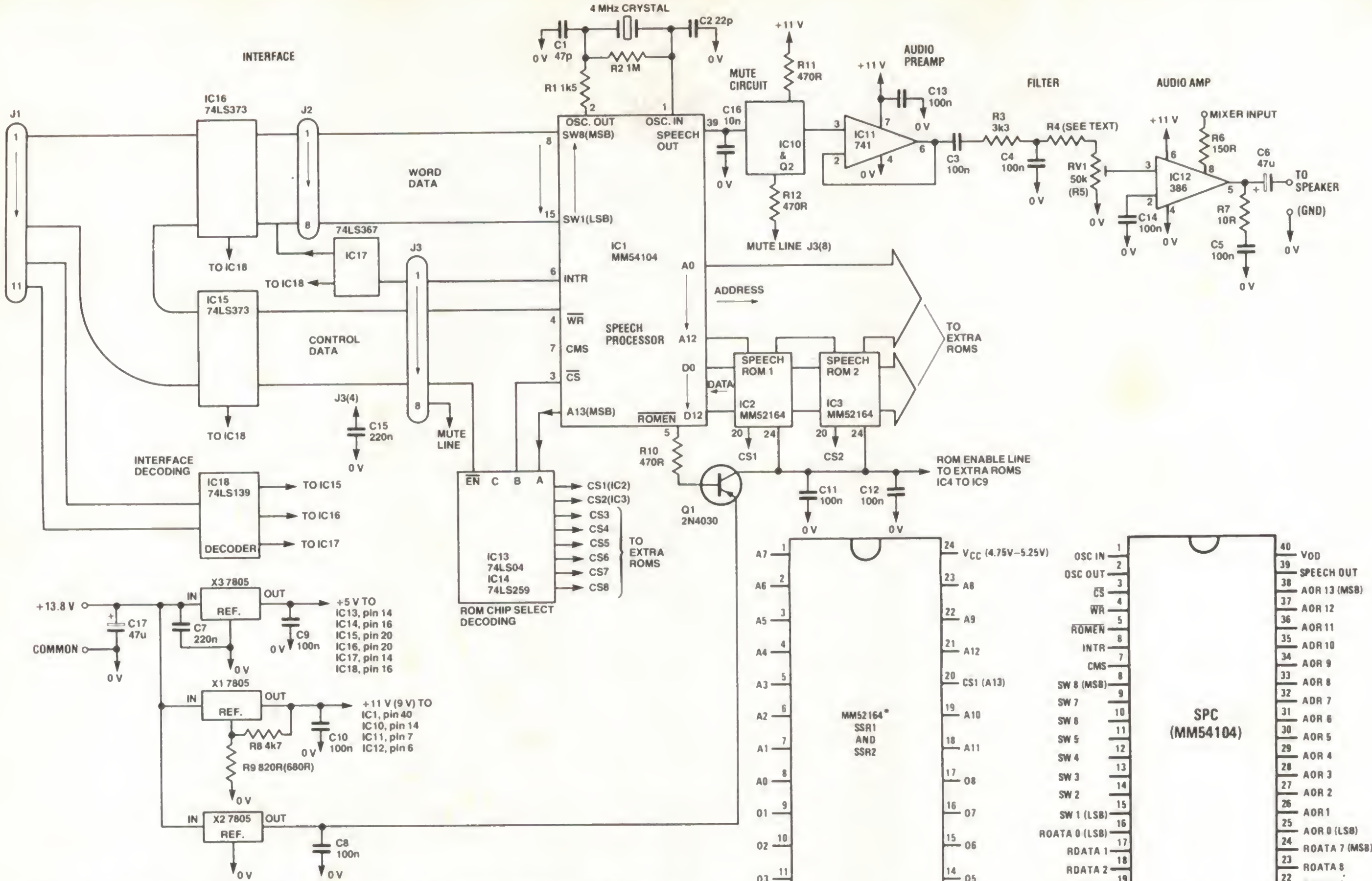


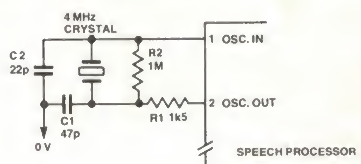
Figure 4. **Block diagram of the 'Turtle Talk' speech synthesiser project.**



Circuit of the ETI-647 'Turtle Talk' speech synthesiser project. Note that, as portions of the circuit are the subject of a patent application, we are not able to give a pin-for-pin circuit but this is sufficient for seeing how it functions and fault-finding.

Note: 'Turtle Talk' is a trademark of Flexible Systems.

The MM54104 IC has facility for a crystal oscillator or can accept an external 'clock' input. This facility provides all the required clock facilities for the chip and provides a frequency reference from which speech frequency information is derived. A 4.000 MHz crystal is employed in this project, the 'osc. in' and 'osc. out' pins of the IC being used to form an oscillator.



Each speech ROM is connected to the address and data busses of the speech processor chip. These busses are entirely internal and do not communicate with the outside world. The ROMs hold all the necessary information to cause each word or sound to be generated by the speech processor. The ROMs are preprogrammed prior to purchase.

The audio section includes the mute, audio preamp, filter, audio amp and mixer. A small gain control trimpot is included so that the sound level may be adjusted.

The mute is an exclusive feature of this design, adding extensive sound handling capabilities to the conventional Digitalker. It nulls the audio output to the speaker without resetting the processor.

The filter is designed to give an optimal frequency response to the stepped analogue data emenating from the speech processor chip. The filter provides a lower cutoff at 200 Hz and a roll off at the high end at around 8 kHz. The speech signal is smoothed and residual sampling frequency noise is removed. An LM386 low voltage audio power amplifier chip provides drive to an external loudspeaker.

The mixer is primarily designed to take the horn input from the Tasman Turtle but could be adopted for other uses, perhaps microphone over-talk, adding tone encoded sounds etc.

The board is intended to be powered from a 13.8 Vdc supply. This is the usual output voltage of most bench supplies rated to provide a nominal 12.5 Vdc output. Three voltage regulators provide power rails for the various portions of the circuit. The speech processor is designed to run from a supply rail of between 7 V and 11 V. An on-board regulator provides a 10.5-11 V rail. The mute and audio circuits are powered from this rail too. If the supply input is likely to fall below 13.2 V, or the supply input is 12-12.6 V, then this rail should be set at around 9 V. This is simply done by changing the value of one resistor.

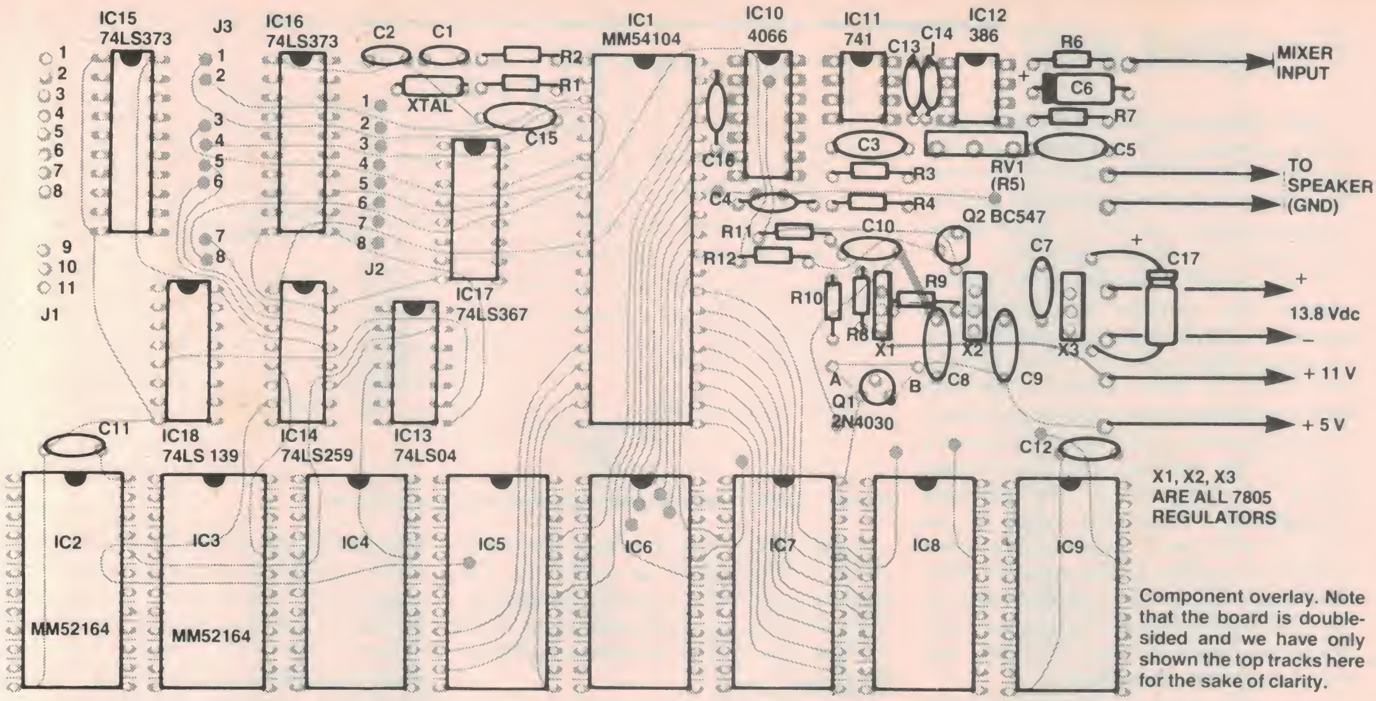
There are two other regulators, each providing a +5 V rail. One supplies the interface and decoding circuitry, the other is used to supply the speech ROMs. As these only need to have the supply voltage present when being accessed, power consumption can be reduced by only turning on the supply to them as required. Accordingly, a 'power saver' circuit is incorporated to effect this.

If a separate source of power is available, the on-board regulators can be dispensed with.

Construction

A double-sided circuit board with plated-through holes is employed. Sockets are used to mount all the ICs. All the other components are soldered directly to the board. We recommend you use a temperature-controlled soldering iron with a small 'wedge' or 'chisel' point as the tracks and pads on the pc board are quite fine. All soldering is done from the *rear side* (i.e: non-component side) of the pc board. Use 20g or 22g resin-cored solder. The pc board tracks are solder plated to aid assembly and help prevent poor joints.

Examine the overlay diagram and identify which way up and which way



Component overlay. Note that the board is double-sided and we have only shown the top tracks here for the sake of clarity.

around the board goes. Commence construction by soldering all the IC sockets in place. Note that they are all orientated in the same direction. If you have your board facing the same way as our overlay shows, pin 1 of all IC sockets is at the *top left hand corner.*

Solder all the resistors in place next. Note that a link is used in place of R4. A resistor is only used here if the synthesiser is to drive a subsequent audio amplifier. The function of R4 is to reduce the level out of the audio amp, IC12 (the 386), while still permitting a reasonable setting range for the gain control trimpot. If contemplating this, a good value to start at would be 10k. Don't solder in the trimpot yet.

If you intend powering the unit from a supply having an output less than 13.2 V, then use a 680 ohm resistor for R9 instead of the 820 ohm value specified, otherwise regulator X1 will not function as the $V_{in} — V_{out}$ voltage may fall below the regulator dropout voltage of 2 V, causing a malfunction of your synthesiser.

Solder all the capacitors in place next. Start with the ceramic capacitors, then solder the greencap (C16) in place and finish with C6. Leave C17 off for the present. Ensure the polarity of C6 corresponds to the overlay.

Now solder in the gain control trimpot — RV1(R5). The trimpot pins may be a tight fit in the holes, but a little gentle pressure will seat them home. Make sure the pads are well heated before applying solder. You might lightly tin the pins of the trimpot before mounting it, also.

The three voltage regulators can now be soldered in place, unless you have provision for off-board power supply rails and don't intend running the board from a 12 V or 13.8 V supply. Make sure you orient them correctly. The overlay shows a thick line on that part of the regulators which have the metal mounting tab, i.e: the tabs of all the regulators face toward the right side of the board, where the dc supply input connects.

Solder the two transistors in next. Make sure these, too, are the right way round. Don't seat Q1 right down on the board. Insert it such that its bottom flange is about 5 — 6 mm off the board. Solder the 4 MHz crystal in place next. Do it quickly so that excessive heat cannot damage the quartz crystal inside the can.

Now solder in place a length of figure-8 flex for the dc supply input. Use a type that has one lead marked (i.e: 'speaker' flex), so that you can identify which is the positive and which is the common lead. Having done that, C17 can be soldered in place. Make sure you get it the right way round.

Now you're ready for an initial test. DON'T PUT ANY ICs IN THEIR SOCKETS YET.

First checks

Make a complete physical check of your work *first.* See that there are no poor joints, no unsoldered leads and no solder 'dags' lying about or solder 'bridges' between tracks or pads. Check that all components are correctly placed. When you're satisfied, you can apply power.

Check voltages at the following points (all with respect to common):

- Input pin of X3 — +13.8 V (or +12 V)
- Output pin of X3 — +5 V
- Output pin of X2 — +5 V
- Output pin of X1 — +11 V (or +9 V)
- Collector of Q1 (case) — 0 V
- Pin 40 of IC1 — +11 V (or +9 V)
- Pin 14 of IC10 — +11 V (or +9 V)
- Pin 20 of IC15 — +5 V
- Pin 24 of IC2 — 0 V ▶

PARTS LIST — ETI-647

Resistors	all ½W, 5% unless noted
R1	1k5
R2	1M
R3	3k3
R4	(link)
R5	(see RV1)
R6	150R
R7	10R
R8	4k7
R9	820R
R10, 11	470R
R12	15k
RV1	10k min. vert. trimpot
Capacitors	
C1	47p ceramic
C2	22p ceramic
C3, 4, 5, 8, 9, 10, 11 12, 13, 14	100n disc ceramic
C7, C15	220n ceramic
C6, C17	47u/16 V electro.
C16	10n greencap
Semiconductors	
IC1	MM54104 SPC
IC2, 3, 4, 5, 6, 7, 8, 9	MM52164 SSR
IC10	4066
IC11	741
IC12	386
IC13	74LS04
IC14	74LS259
IC15, 16	74LS373
IC17	74LS367
IC18	74LS139
X1, 2, 3	7805, LM340T5
Q1	2N4030
Q2	BC547

Miscellaneous

ETI-647 pc board (TTB-A) — this board is copyright to Flexible Systems who are the sole supplier; 4 MHz HC18/u crystal; IC sockets — 1 x 40 pin, 2 x 24 pin (or 8 x), 2 x 20 pin, 3 x 16 pin, 2 x 14 pin, 2 x 8 pin; ribbon cable and DIP headers or plugs to suit connection to computer; loudspeaker to suit; figure-8 cable, etc.

Price estimate $240 — $250

Now, solder one end of a short 'jumper' lead to common (0 V) and plug the other end into pin 5 of IC1's socket. Now check the voltage on the collector of Q1 and the voltage on pin 24 of IC2 — these should both read +5 V. If not, check R10.

If all is well, disconnect the power, remove the jumper and connect a speaker to the speaker output pads on the board. Place the 741 (IC11) and the 386 (IC12) in their sockets — making sure you get them the right way round.

Apply power again. You should hear a click in the speaker. Set the trimpot wiper to mid-position (i.e: pointing straight up). Touch the wiper of the trimpot with your finger. Some noise should be audible in the speaker. Now touch pin 3 of the 741. A distinct buzz or hum should be heard. If all is not well, check the audio circuitry for faults and fix it if anything is suspect.

Turn off the power and put IC10, the 4066, in its socket. Apply power again. Touching pin 1 should cause a slight noise to be heard in the speaker, touching pin 2 should do the same. Temporarily jumper pin 8 of J3 to the +5 V aux. supply input. Now touch pin 2 of the 4066. No noise should be heard in the speaker. If not, check that R12 is correct and the Q2 is OK and correctly oriented. Remove power. Put all the other (LS-TTL) ICs in their sockets. Apply power and check that +5 V appears on the upper right hand pin of each. Remove power.

Now you can insert IC1 in its socket. Note that it is a MOS chip and should be supplied in conductive foam or other conductive package. Use the usual MOS-handling precautions when inserting it in its socket. Make sure you don't bend any leads under the chip package. Apply power once again and check that you get +11 V (or +9 V) on pin 40. If you have a CRO, check pins 1 and 2 for signs of oscillation — you should get a 4 MHz sinewave here. The amplitudes on the two pins will differ. (Pin 1 will have the greater amplitude signal — you may need a x10 probe to avoid 'loading' of the circuit causing it to cease oscillation). Alternatively a receiver covering this frequency could be used. You should find a strong signal on 4 MHz. If no sign of oscillation can be found, remove power and check the circuit and components around the crystal.

If all is well, remove power and insert the two speech ROMs, IC2 and IC3. These, like IC1, are also MOS devices so take care of them. One of these is marked SSR1 — this is IC2. The one marked SSR2 is IC3. Above all, make sure you insert them the right way round. See that no pins get bent under the package when inserting them into the sockets.

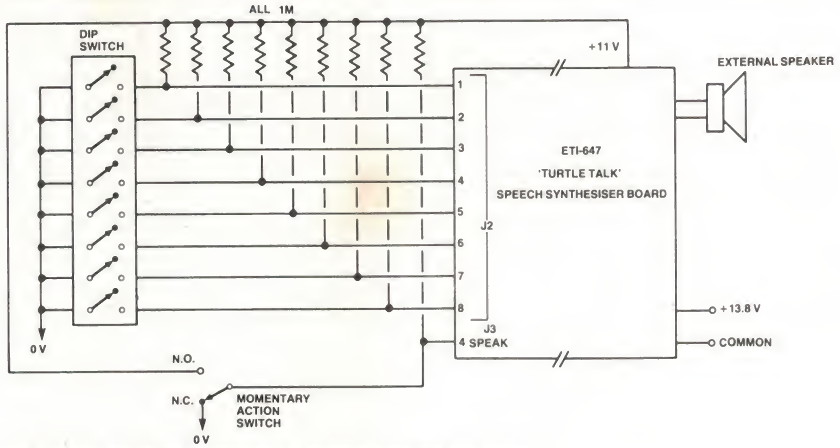


Figure 6. **Circuit suitable for testing the speech synthesiser board.**

Apply power. You may hear the words "This is Digitalker" at switch-on. Try bridging pin 4 of IC1 briefly to common. This should cause the board to say "This is Digitalker". If not, recheck everything.

Talking test

For this you will need an 8-way DIP switch, nine 1M resistors, a momentary action SPDT switch and either some ribbon cable or a host of hookup wire. Wire up the circuit shown in Figure 6. (Note that 0 V goes to COMMON on the pc board.) Set all the DIP switches ON. This puts a low on all the address lines of J2. Apply power and operate the momentary action switch. Your synthesiser should say "This is Digitalker". If not, check your wiring. If it's OK, you're probably sick of hearing "This is Digitalker" so set up another address on the DIP switch by consulting the accompanying table. Upon operating the momentary action switch you should hear the word set-up. Try a few others.

All OK? Well, you're ready to 'Turtle Talk'! ●

(. . . to be continued).

TABLE I. DT1050 MASTER WORD LIST

Word	8-Bit Binary Address SW8 … SW1		8-Bit Binary Address SW8 … SW1		8-Bit Binary Address SW8 … SW1
THIS IS DIGITALKER	00000000	Q	00110000	IS	01100000
ONE	00000001	R	00110001	IT	01100001
TWO	00000010	S	00110010	KILO	01100010
THREE	00000011	T	00110011	LEFT	01100011
FOUR	00000100	U	W0110100	LESS	01100100
FIVE	00000101	V	00110101	LESSER	01100101
SIX	00000110	W	00110110	LIMIT	01100110
SEVEN	00000111	X	00110111	LOW	01100111
EIGHT	00001000	Y	00111000	LOWER	01101000
NINE	00001001	Z	00111001	MARK	01101001
TEN	00001010	AGAIN	00111010	METER	01101010
ELEVEN	00001011	AMPERE	00111011	MILE	01101011
TWELVE	00001100	AND	00111100	MILLI	01101100
THIRTEEN	00001101	AT	00111101	MINUS	01101101
FOURTEEN	00001110	CANCEL	00111110	MINUTE	01101110
FIFTEEN	00001111	CASE	00111111	NEAR	01101111
SIXTEEN	00010000	CENT	01000000	NUMBER	01110000
SEVENTEEN	00010001	400HERTZ TONE	01000001	OF	01110001
EIGHTEEN	00010010	80HERTZ TONE	01000010	OFF	01110010
NINETEEN	00010011	20MS SILENCE	01000011	ON	01110011
TWENTY	00010100	40MS SILENCE	01000100	OUT	01110100
THIRTY	00010101	80MS SILENCE	01000101	OVER	01110101
FORTY	00010110	160MS SILENCE	01000110	PARENTHESIS	01110110
FIFTY	00010111	320MS SILENCE	01000111	PERCENT	01110111
SIXTY	00011000	CENTI	01001000	PLEASE	01111000
SEVENTY	00011001	CHECK	01001001	PLUS	01111001
EIGHTY	00011010	COMMA	01001010	POINT	01111010
NINETY	00011011	CONTROL	01001011	POUND	01111011
HUNDRED	00011100	DANGER	01001100	PULSES	01111100
THOUSAND	00011101	DEGREE	01001101	RATE	01111101
MILLION	00011110	DOLLAR	01001110	RE	01111110
ZERO	00011111	DOWN	01001111	READY	01111111
A	00100000	EQUAL	01010000	RIGHT	10000000
B	00100001	ERROR	01010001	SS (Note 1)	10000001
C	00100010	FEET	01010010	SECOND	10000010
D	00100011	FLOW	01010011	SET	10000011
E	00100100	FUEL	01010100	SPACE	10000100
F	00100101	GALLON	01010101	SPEED	10000101
G	00100110	GO	01010110	STAR	10000110
H	00100111	GRAM	01010111	START	10000111
I	00101000	GREAT	01011000	STOP	10001000
J	00101001	GREATER	01011001	THAN	10001001
K	00101010	HAVE	01011010	THE	10001010
L	00101011	HIGH	01011011	TIME	10001011
M	00101100	HIGHER	01011100	TRY	10001100
N	00101101	HOUR	01011101	UP	10001101
O	00101110	IN	01011110	VOLT	10001110
P	00101111	INCHES	01011111	WEIGHT (Note 2)	10001111

Note 1: "SS" makes any singular word plural

Note 2: Address 143 is the last legal address in this particular word list. Exceeding address 143 will produce pieces of unintelligible invalid speech data.

C. Itoh PRINTERS

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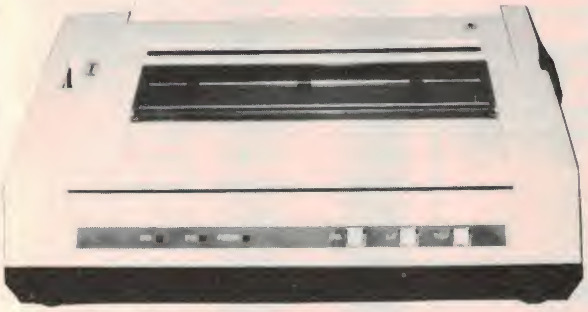

Pro/Writer Printer 8510

Print Features: Number of columns—136 col. max. Print Speed—120 CPS. Print Direction—Single-directional and Bidirectional, Switch Selectable. Throughput Speed—From 44 to 152 lpm. Character spacing (max. number of columns per line)—Pica 10 CPI (80), Double Width 5 CPI (40), Compressed Font 17 CPI (136), Double Width 8.5 CPI (68), Elite 12 CPI (96), Double Width 6 CPI (48), Proportional Double Width Proportional. Line Spacing—Variable to 1/144". Print Width—203 mm (8") max.
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Error Detection: (1) Parity (VRC)—Odd, Even, No-parity. Switch selectable. (2) Framing Error—Stop bit check. (3) Overrun Error—Error is detected when data are received before the previous data have been processed.
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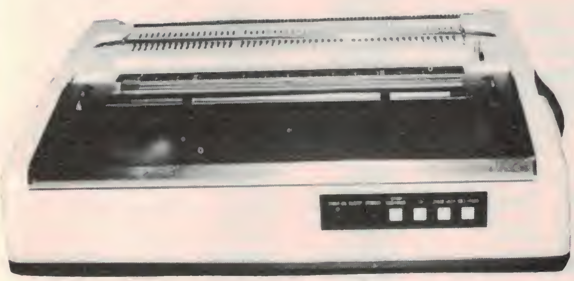
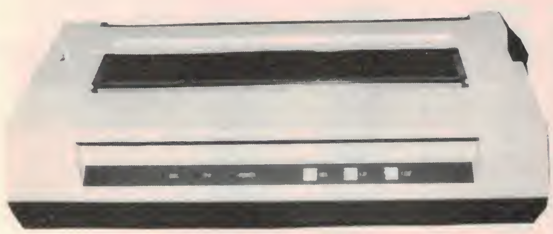


Model 1550

The Model 1550 is a compact desk-top dot matrix serial impact printer used for data communication terminals, hardcopy of CRT displays, peripheral terminals for minicomputers and microcomputers, and small-sized business systems.
The character format is a dot matrix of 7(H) x 9)(V). or 8(H) x 8(V).
Print speed is 120 characters/second. Up to 136 characters can be printed per line at 10 CPI.
Its main features are: ● Compact desk-top dot matrix printer ● 136-column print ● Light-weight ● Low power-consumption ● High-quality print ● Bit image graphics ● Graphic Symbols ● Prints in six different languages ● High reliability ● Low cost.



F-10 Printmaster Daisy Wheel Printer

Print Speed: 40 CPS. **Print Method:** Static Print Impact. **Number of Printable Columns:** 136, 163, Variable. **Character Spacing:** 1/120 Inch (minimum). **Line Spacing:** 1/48. **Return Time:** 900 msec. **Line Feed Time** 40 msec. **Paper Width:** 406 mm (maximum). **Print Characters:** 96. **Printwheel:** Industry Standard 96 Character Wheel. **Interface:** Industry Standard 8-bit Parallel, RS232-C Compatible, X-ON, X-OFF, 12-bit Qume and Diablo Compatible. **Dimensions:** 574 mm W x 405 mm d x 153.5 mm H (22.5" W x 15.9" D x 6" H). **Weight:** 14 kg (30.8 lbs.) with cover and power supply. **Noise:** Less than 65 Db (1M from Platen, A Scale).

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ETI 9/82/6

This month we have two programs for you, both contributed by readers. The first program, Dice, has the instructions listed in the way we have done with most programs to date, so you can see how it works and get ideas for using in your own programs. The second, Greeblie Catcher, is listed in a 'compact' form, showing the program code only. We will be publishing more programs in this fashion in the future, leaving it to you to disassemble them. However, the author of Greeblie Catcher has included notes on the structure and workings of his program so you can see what's going on.

DICE

Adrian Ollerenshaw
O'Sullivan Beach, S.A.

This program 'throws' any number of dice up to six at a time and displays a row of real dice patterns. At the start of the program the screen is blank. Pressing any key from 0 to 6 causes that number of dice to be thrown and displayed (0 gives no throw). For another throw, simply press any key to erase the screen and then the key corresponding to the number of dice to be thrown.

Much better than boring old plastic dice that roll off the table when you least want them to, eh?!

```
0600   6A00   set VA=00
0602   6B00   set VB=00
0604   F10A   V1=KEY PRESSED
0606   4100   SKF V1=00
0608   1604   GOTO 0604
060A   62F9   SET V2=F9
060C   8214   V2=V2+V4
060E   3F01   SKF VF=01
0610   1616   GOTO 0616
0612   6F00   VF=00
0614   1604   GOTO 0604
0616   CC07   VC=RND AND 00
0618   4C00   SKF VC≠00
061A   1616   GOTO 0616
061C   4C07   SKF VC≠07
061E   1616   GOTO 0616
0620   A65C   I=065C
0622   4C01   SKF VC≠01
0624   1640   GOTO 0640
0626   A662   I=0662
0628   4C02   SKF VC≠02
062A   1640   GOTO 0640
062C   A668   I=0668
062E   4C03   SKF VC≠03
0630   1640   GOTO 0640
0632   A66E   I=066E
0634   4C04   SKF VC≠04
0636   1640   GOTO 0640
0638   A674   I=0674
063A   4C05   SKF VC≠05
063C   1640   GOTO 0640
063E   A67A   I=067A
0640   DAB7   SHOW 7 BYTES AT
0642   6E0A   VE=0A         VA,VB
0644   FE18   TONE=VE
0646   FE15   TIMER=VE
0648   FE07   VE=07
064A   3E00   SKF VE=00
064C   1648   GOTO 0648
064E   7A08   VA=VA+08
0650   71FF   V1=V1+FF
0652   3100   SKF V1=00
0654   1616   GOTO 0616
0656   F10A   V1=KEY PRESSED
0658   00E0   CLEAR SCREEN
065A   1600   GOTO 0600
065C   FEFE   .
065E   FEEE   .
0660   FEFE   .
0662   FEBE   dice patterns
0664   FEFE   .
0666   FEFA   .
0668   FEBE   .
066A   FEEE
066C   FEFA
066E   FEBA
0670   FEFE
0672   FEBA
0674   FEBA
0676   FEEE
0678   FEBA
067A   FEAA
067C   FEFE
067E   FEAA
0680   FE00
```

GREEBLIE CATCHER

Robert Atkinson
Jamberoo, NSW

This is a games program which consists of a moveable 'catcher' and two 'greeblies' which you attempt to catch as they move down the screen. Each greeblie caught is stored at the left hand side of the screen for later stewing in galah fat, or as a score, or whatever tickles your imagination.

The greeblies appear randomly and move down and across the screen in a random manner. You have to position your catcher underneath them before they hit the bottom. Five misses and the game ends!

You can move your catcher quickly or slowly left or right to catch a greeblie. Here are the key functions:

0 . . . . fast left
1 . . . . slow left
5 . . . . slow right
6 . . . . fast right

The program contains three sets of subroutines which are called by the program mainline. Initialisation, or program setup, is from 0600 to 061F. The program mainline runs from 0620 to 0670. It proceeds in the following steps: undraw catcher — add movement variables — check end of travel? — draw catcher — do greeblie subroutines — set movement variables — check if end of game? — go back to start. A total of eleven variables are used:

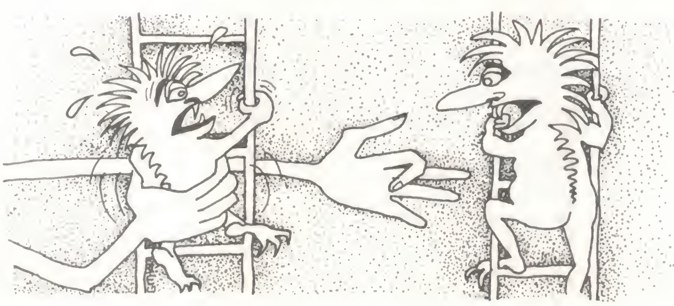
A, B . . . . catcher
4, 5, 6, 7 . . . . greeblies
8, 9 . . . . store
1 . . . . misses
E . . . . randomiser
C . . . . movement variable

The greeblie subroutines are at 0670 to 069F (greeblie A) and 06A0 to 06AF (greeblie B). There is a further subroutine at 06D0 to 07FF, for storing the greeblies.

The greeblie subroutines follow the following sequence: undraw — random movement — check end of travel? — check if missed — draw — check if hit catcher? — if yes, go to store — return — (end of travel) add 1 to misses — start at random location at top of screen — return.

Go get them greeblies!

0600	A6E8	6A02	6B2C	DAB3	0678	85E4	CE02	7EFF	84E4
0608	C42F	6500	A6E8	D452	0680	4530	1698	4400	6402
0610	C62F	6700	A6EB	D672	0688	442F	642E	D452	4F00
0618	6832	6900	6100	6D00	0690	163A	26D0	D452	169A
0620	A6E8	DAB3	8AC4	4A2F	0698	7101	C42F	6500	1684
0628	6A2E	4A30	6A2E	4A00	06A0	A6EB	D672	CE02	7EFF
0630	6A02	4A01	6A02	DAB3	06A8	86E4	CE02	87E4	00FF
0638	1670	16A0	00FF	00FF	06B0	4730	16C8	4600	6602
0640	00FF	00FF	6C00	00FF	06B8	462F	662E	D672	4F00
0648	6E00	EEA1	6CFE	6E01	06C0	163C	26D0	D672	16CA
0650	EEA1	6CFF	6E05	EEA1	06C8	7101	C62F	6700	16B4
0658	6C01	6E06	EEA1	6C02	06D0	FA18	00FF	00FF	4530
0660	A6E8	3105	1620	0000	06D8	00EE	D892	7804	383E
0668	00FF	00FF	00FF	00FF	06E0	00EE	6832	7904	00EE
0670	A6EE	D452	CE01	7E01	06E8	8181	FF20	5000	5020



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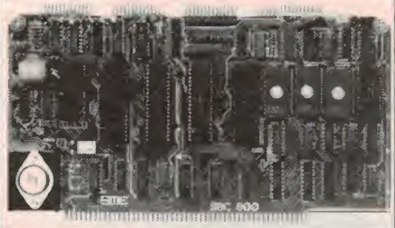
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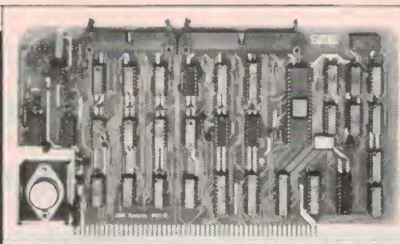
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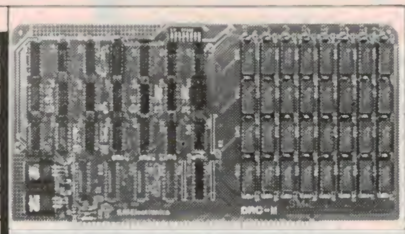
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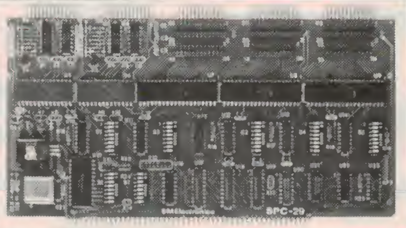
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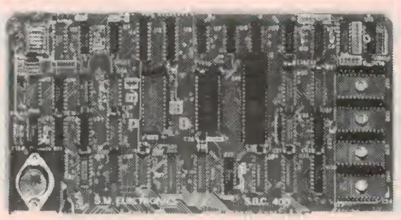
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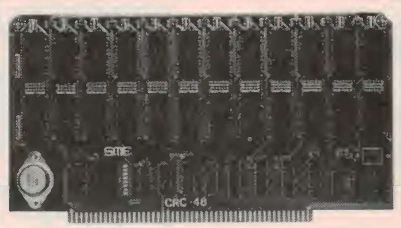
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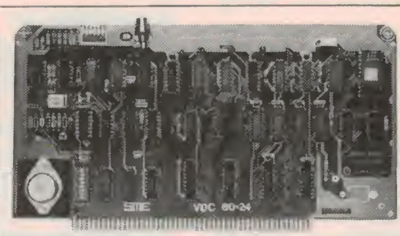
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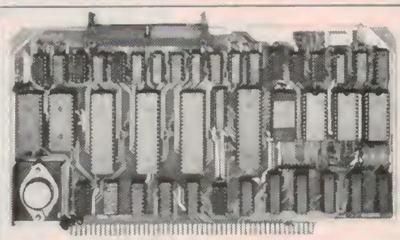
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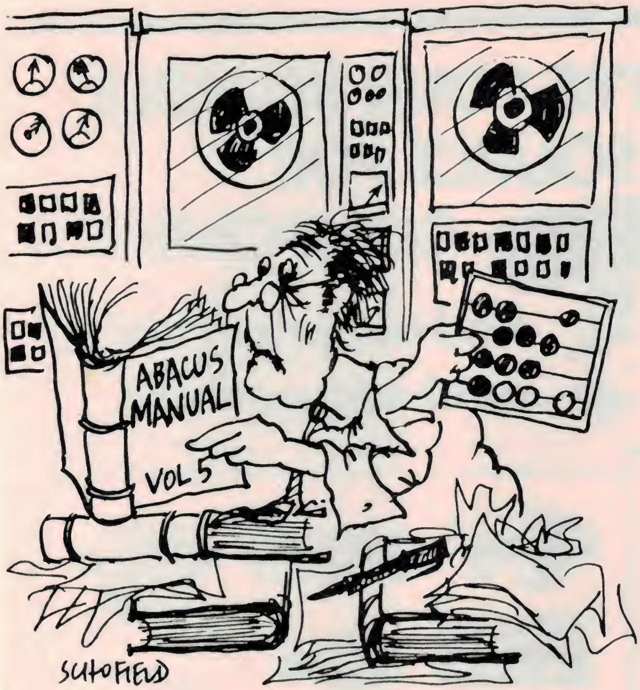

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The refined Turtle

Assembling the turtle produced a few problems for Stephen Thomas. So after a period of teeth-gnashing and hair-tearing he has made some mechanical and electronic modifications. He now has a refined pet, better trained than the original rascal.

Stephen Thomas

Mechanical modifications

I assembled the turtle as described (April, May and June issues of ETI) and found that the pen solenoid plunger not only touched the base plate, but was pushed in by about 4 mm. I thought that if I glued the grommet under the plunger, as was suggested, the plunger would have even less space in which to move.

So I figured out that the top plate could move up by 12.7 mm (that's half an inch) and would still fit comfortably under the dome. This led to the revised mounting arrangements shown in Figure 1(b).

A side effect of this method is that the pc board can be secured before the long bolts are installed, so that less juggling is required to get the top plate screwed down. This has benefits when you come to mount further pc boards in the Turtle at a later date.

And I found another problem with the solenoid. The bolts holding down the plate, which stops the plunger from twisting, made it difficult to mount the speaker. This situation was made even worse by using Silastic which, although it is an excellent sealant, is a somewhat dubious glue. So I made a little widget out of masonite to go between the solenoid and the speaker (with a cutout for the bolt head) and stuck them all together with epoxy as shown in Figure 2.

I had a problem with the pen alignment and could not persuade the confounded animal to produce coherent graphics. The main problem was at corners, where the pen would describe a sort of random small arc before setting off on a straight line again. Wobble in the solenoid plunger was part of the problem. I could not adequately adjust the centering of the pen either. I altered the pen assembly as shown in Figure 2. I cut and bent up a four-fingered 'claw' from sheet metal and attached it to the original pen bracket. The pen is held loosely in this claw with the original pen clamp permitting limited up-down movement. The bracket also permits an amount of horizontal movement. To position the pen, I made an adjustable 'slidey' plate from aluminium and bolted this over the original pen hole in the base which I had enlarged. I cut slots in the base and corresponding slots in the ▶

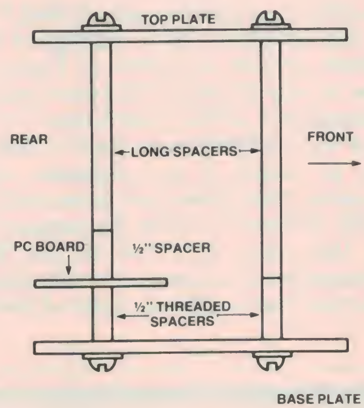


Figure 1(a). **Original mounting arrangements.**

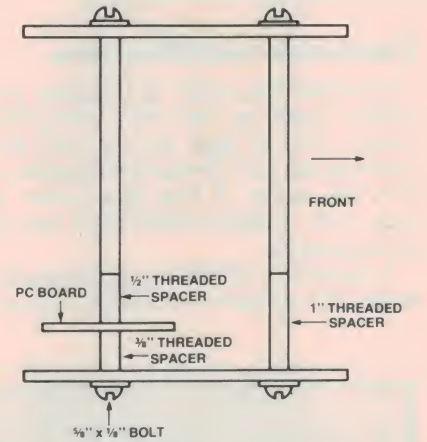


Figure 1(b). **Better arrangement for mounting top plate to base plate.**

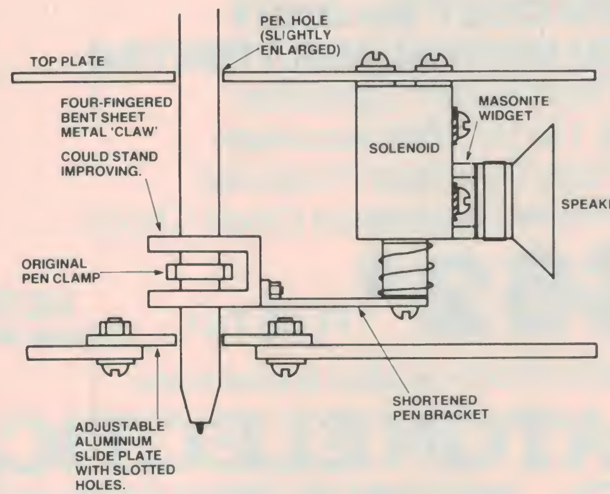


Figure 2. **Modifications with aluminium slide plate and widget.**

The refined Turtle

adjustable plate, but running at right angles to the slots in the base, as shown in Figure 3. This permits a considerable latitude of adjustment for perfect centering of the pen.

With the pen set up this way the graphics improve out of sight and any wobble in the solenoid plunger is immaterial.

If I can lay my hands on another wooden 'foot', I am going to put it on the back of the turtle. I have a rather long, heavy control cable and I find that the foolish reptile will occasionally lurch backwards, completely ruining the graphics design it's working on.

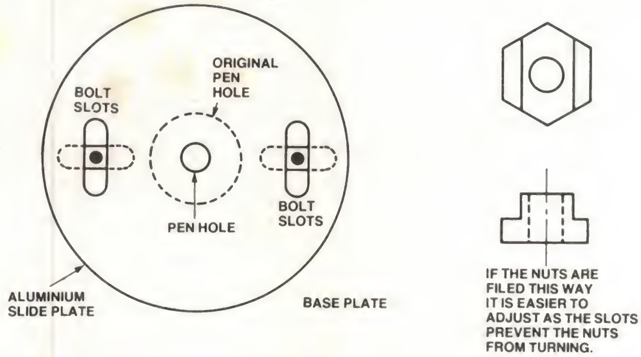


Figure 3.

Electronic modifications

I reversed the order of the grey and yellow leads on the left motor. This means that a high on the 'set' line corresponds to a forward movement of the left motor. I find this easier to cope with, software-wise, than the old arrangement.

I installed a 1N4007 diode across the solenoid to protect its transistor driver.

I didn't particularly care to feed 12 V to the interface, so I redesigned the sensor circuits as shown in Figure 4. The 'A' side of a 6821 PIA reads 'high' if unconnected, so this modification works very well. I didn't even need to modify the pc board. I just replaced some resistors with diodes and connected the LEDs differently. With the sensors set up this way, a '1' bit in the PIA corresponds to a bumped switch which is better from a software point of view. ●

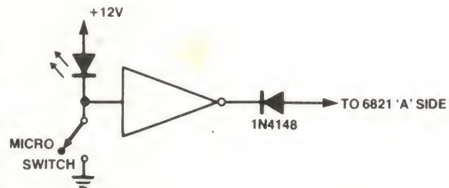


Figure 4. **Redesigned sensor circuits.**

RS232 serial interface troubleshooter

Making a 'standard' RS232 interface work can be a nightmare. 'Standards' not withstanding, you can regain lost sleep with this troubleshooting unit.

Graham Wideman

IN LAST MONTH'S ETI we explained how computer serial interfaces of the RS232 type are supposed to work, and why they frequently won't. This month we present the design and construction details of a test unit which solves most of these problems. You may wish to build it as described here, or simply borrow the principles to troubleshoot interfaces using other instruments.

The troubleshooter provides the capability to patch together any wiring arrangement, and to monitor what is happening on each wire. In this much it parallels the better commercially-available RS232 'problem solvers'.

However, it also includes an apparatus for determining exactly which interface wires are outputs, inputs, not connected, or shorted, thereby making possible a complete picture of a totally unknown interface. This is extremely useful if the equipment in question has no manual, or as is more likely, has a manual which leaves the subject of the RS232 interface completely ambiguous.

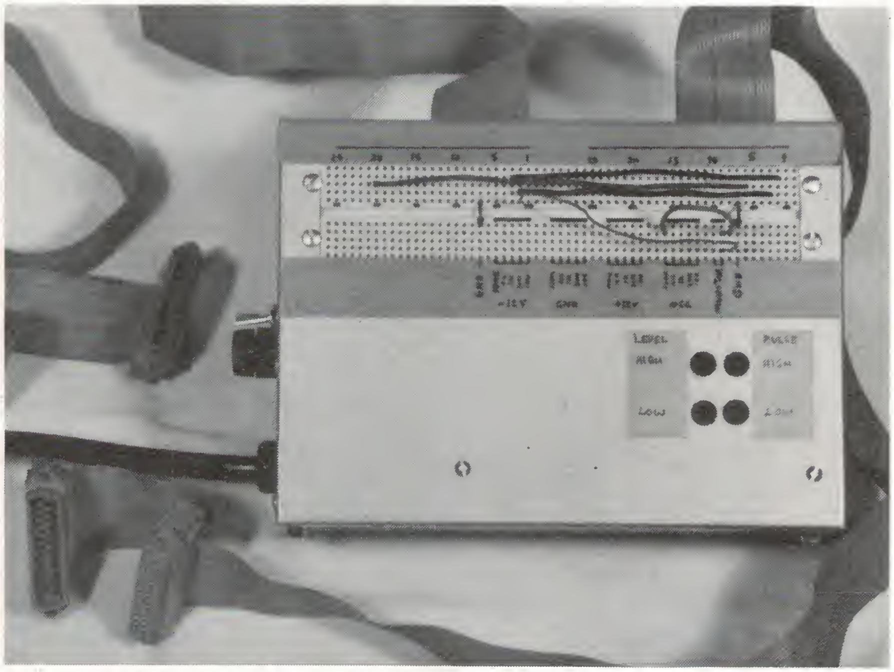


Figure 1. **The RS232 troubleshooter.**

Patching board

The heart of the troubleshooter is a breadboard patching block which is wired permanently to a pair of ribbon cables, each cable having attached to it both male and female DB25 connectors of the 'insulation displacement' squash-on variety. After peeling the adhesive plastic backing off the breadboard block (and cleaning it up a bit), the individual conductors of the ribbon cable are soldered to the *underside* of the rows of contacts in the breadboard, as shown in the photo of Figure 2, and detailed in the diagram of Figure 3.

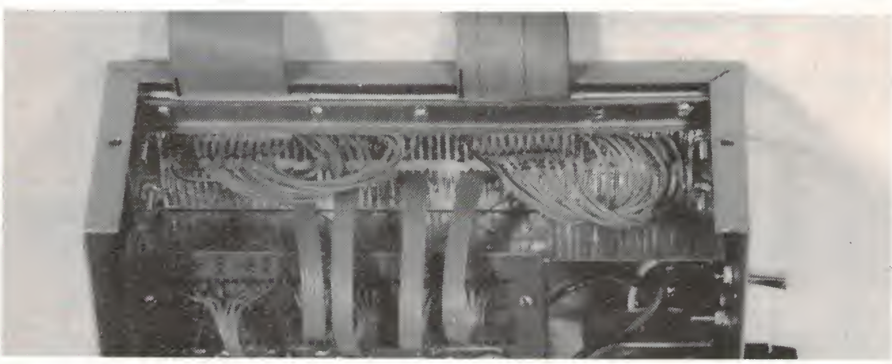


Figure 2. **Closer view of breadboard area used for patching the troubleshooter's two DB25-equipped ribbon cables, and for connection to the unit's signal monitor and test signals.**

This simple device already gives two capabilities, as shown in Figure 4. First, both cables can be attached, one to each of the pieces of equipment which are to be interfaced together. Having both a male and female connector on each cable ensures that plugging in will be no problem. Then the particular pin-to-pin wiring can quickly be tried out using jumper wires on the tester's breadboard patching area, before a permanent cable is made up.

The second way to use the device as so far described, is for 'tapping into' an existing interface arrangement which is now perhaps malfunctioning. Suppose

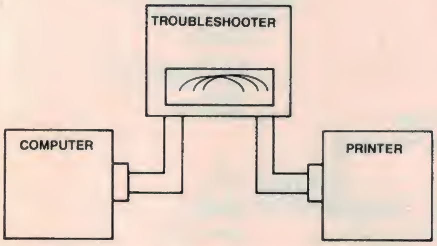


Figure 4a. **Using the troubleshooter's patching area to rig new trial cable before making permanent version.**

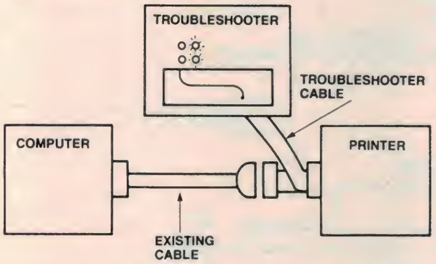


Figure 4b. **Using just one ribbon cable, the troubleshooter provides a convenient way to tap into and monitor the signals on a 'supposed to be working' RS232 hookup.**

the 'existing system' is a computer talking to a printer. Simply unplug one end of the computer-to-printer cable (let's say the printer end), and plug it into one of the two connectors (male or female as appropriate) on one of the troubleshooter's ribbons. Plug the remaining connector on the *same* ribbon into the receptacle on the printer. Now the short length of ribbon between male and female DB25s carries the connection from computer to printer, and in addition this ribbon brings out all 25 lines to the breadboard where they may be conveniently monitored.

Signal monitor

In order to monitor the signals on an RS232 line it is possible to get away with simply a LED with a resistor in series. However this loads the line, possibly changing the conditions you were trying to monitor. Additionally, you would not see any quick pulses of activity which may be important.

Consequently the monitor incorporated in this tester has been designed to address these two problems. Four LEDs are used, two to indicate a steady high or low level, while the other two flash on for about a half second in response to a positive or negative pulse. The level LEDs respond only to valid high or low signals; a voltage in the middle (around zero), or an open line will cause neither LED to illuminate. The LEDs are powered from a built-in mains power supply, and the RS232 line is monitored via high impedance buffers, so as not to disturb it.

(It should be remembered here that the RS232 line levels are -3 V to -12 V for a 'low' representing a data '1', and $+3$ V to $+12$ V for a 'high' representing a 'zero'. With no data the line sits at low.)

The monitor input is soldered to the underside of a contact strip on the breadboard (actually two strips, in case of wear), and thus may be patched to any other contact as desired for observation of the signals there. ▶

```
Test_Signals                                    From_DB25s
                                   Ribbon
                  ooooo  ooooo          DB25
                  ooooo  ooooo     24   25   DB25 Cable A
                  ooooo  ooooo     22   24        |
                  ooooo  ooooo     20   23        |
                  ooooo  ooooo     18   22        |
                  ooooo  ooooo     16   21        |
                  ooooo  ooooo     14   20        |
                  ooooo  ooooo     12   19        |
                  ooooo  ooooo     10   18        |
                  ooooo  ooooo      8   17        |
                  ooooo  ooooo      6   16        |
                  ooooo  ooooo      4   15        |
                  ooooo  ooooo      2   14        |
                  ooooo  ooooo     25   13        |
                  ooooo  ooooo     23   12        |
                  ooooo  ooooo     21   11        |
                  ooooo  ooooo     19   10        |
                  ooooo  ooooo     17    9        |
                  ooooo  ooooo     15    8        |
       Ground     ooooo--ooooo     13    7        |
                  ooooo  ooooo     11    6        |
-12V      100k    ooooo  ooooo      9    5        |
 "          4k    ooooo  ooooo      7    4        |
 "          1k    ooooo  ooooo      5    3        |
 "         300    ooooo  ooooo      3    2        |
 "         100    ooooo  ooooo      1    1   DB25 Cable A
                  ooooo  ooooo
                  ooooo  ooooo
Ground    100k    ooooo  ooooo
 "          4k    ooooo  ooooo
 "          1k    ooooo  ooooo
 "         300    ooooo  ooooo
 "         100    ooooo  ooooo
                  ooooo  ooooo     24   25   DB25 Cable B
                  ooooo  ooooo     22   24        |
+12V      100k    ooooo  ooooo     20   23        |
 "          4k    ooooo  ooooo     18   22        |
 "          1k    ooooo  ooooo     16   21        |
 "         300    ooooo  ooooo     14   20        |
 "         100    ooooo  ooooo     12   19        |
                  ooooo  ooooo     10   18        |
                  ooooo  ooooo      8   17        |
Osc.      100k    ooooo  ooooo      6   16        |
 "          4k    ooooo  ooooo      4   15        |
 "          1k    ooooo  ooooo      2   14        |
 "         300    ooooo  ooooo     25   13        |
 "         100    ooooo  ooooo     23   12        |
                  ooooo  ooooo     21   11        |
Monitor           ooooo  ooooo     19   10        |
 "                ooooo  ooooo     17    9        |
                  ooooo  ooooo     15    8        |
       Ground     ooooo--ooooo     13    7        |
                  ooooo  ooooo     11    6        |
                  ooooo  ooooo      9    5        |
                  ooooo  ooooo      7    4        |
                  ooooo  ooooo      5    3        |
                  ooooo  ooooo      3    2        |
                  ooooo  ooooo      1    1   DB25 Cable B
                  ooooo  ooooo
```

Figure 3. **Diagram showing one possible arrangement for the breadboard connection area. Note that the DB25 ribbon cables occupy one 'side' of the board, and the test monitor and signals occupy the other. Opposite each ribbon's pin number 7 is a ground connection, across which would normally be installed a small jumper.**

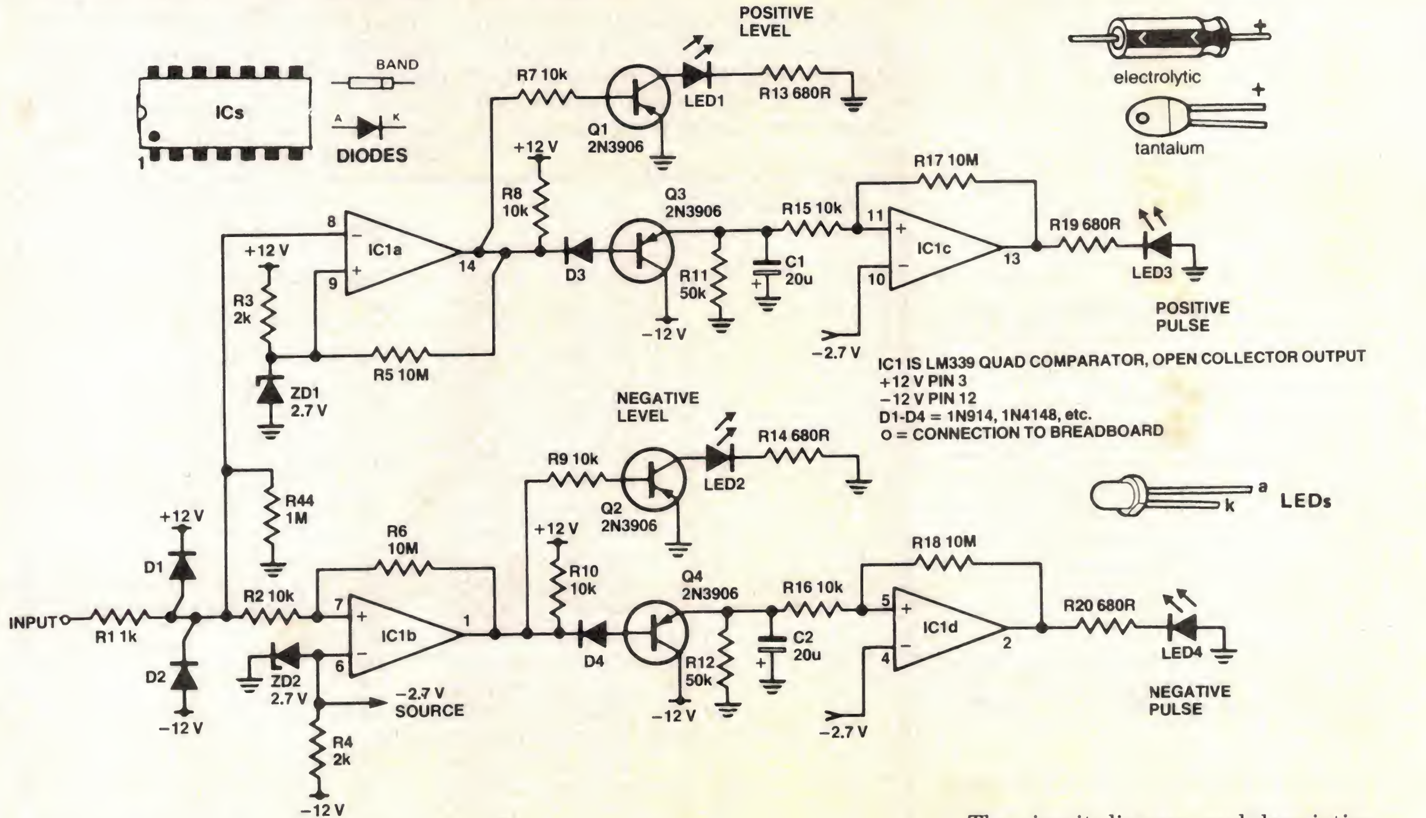


Figure 5. **Circuit diagram of monitor section.**

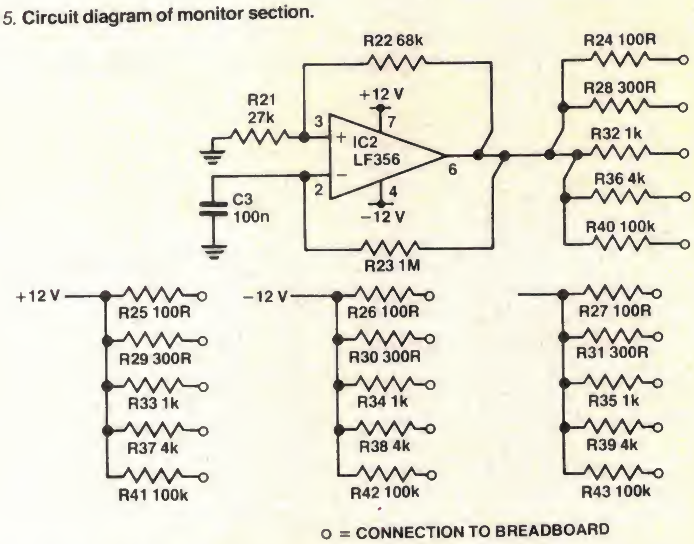
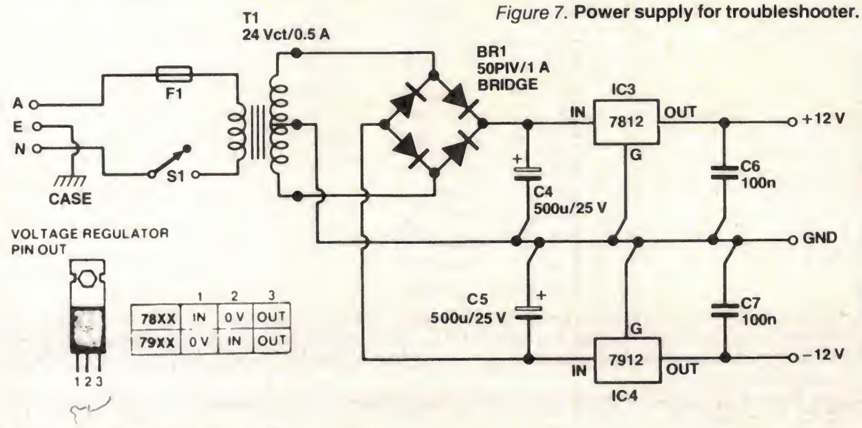


Figure 6. **Circuit of test oscillator, and other test levels.**

Figure 7. **Power supply for troubleshooter.**



The circuit diagram and description for the monitor, the test oscillator to be described, along with the power supply, are to be found in Figures 5 to 7.

Generated signals

Of immediately obvious use are the 'high' and 'low' signals provided. These may be used to apply 'halt' or 'go' signals to handshaking lines. Additionally there is built-in a square-wave generator which continuously oscillates between high and low conditions at a rate of approximately five times per second.

Each of these signals, along with ground, is supplied to contacts on the breadboard via a selection of resistors, from 100 ohms to 100k ohms. The usefulness of this arrangement may not be immediately apparent, and for explanation I must describe the electronic circuits which transmit or receive on an RS232 line.

How it works

The monitor

The schematics for the troubleshooter's main monitor, test oscillator and power supply are to be seen in Figures 5 to 7.

Components R1-D1-D2 prevent the input signal from causing damage should it happen to exceed the troubleshooter's power rail limits. From there the input signal is routed to two very similar 'channels', one concerned with 'high' levels and pulses, the other with 'low' levels and pulses.

Looking then at the positive channel, the input signal arrives at the negative input of comparator IC1a, where it is compared to a reference of about 2V7 (which is set by ZD1 at the positive input of IC1a). Supposing that the input signal exceeds 2V7, then IC1a's output is low, turning on Q1 via R7, and illuminating LED1 to indicate a 'high level'.

At the same time, the low level (about −10 V) at the output of IC1a turns on Q3, quickly charging C1 'down' to about −9 V. IC1c sees this voltage and compares it to −2V7, sees that it is lower and lowers its own output illuminating LED3 to indicate a 'high pulse'.

If the monitor input now drops below 2V7, IC1a's output will go high, turning off Q1 and the 'high-level' LED1, and also Q3. However the 'high pulse' LED3 will remain on for a short while (about a half second) as C1 is charged up past the 2V7 point by R11. Notice that this delayed LED3 action would have occured even if LED1 had been on for only an invisibly short length of time. Hence LED3 makes visible short pulses which cannot be seen by simply watching the level, whether on the troubleshooter's level LEDs, or even with an oscilloscope.

The negative channel works similarly, the only change being to swap the positive and negative inputs of the input comparator.

Test oscillator

As we shall see, IC2's output must sit in either high (about +10 V) or low (about −10 V) states. Let us assume it is initially low, and that C3 starts out uncharged, so that there is 0 V at the op-amp's negative input.

Since the op-amp output is at say −10 V, the positive input will be at approximately −3 V, established by the R21-R22 voltage divider. Remembering that we assumed the negative input to be at 0 V, the 'low' output will remain temporarily unchanged.

However, the low output will charge C3 via R23 downwards. After a while the op-amp negative input will be less than its positive input (at −3 V), and thus the output will change states to +10 V. When this happens the voltage at the positive input changes, of course, to +3 V, maintaining this state of affairs.

Again we must wait for C3 to be charged via R23, this time up to +3 V. You should be able to see that this oscillating action will continue, and that the period is the time taken for C3 to charge from −3 V to +3 V, then back down to −3 V, when R23 is pulled up to +10 V and then down to −10 V respectively.

The values given provide a frequency of about 5 Hz, quite suitable for this testing purpose.

The oscillator output is delivered to the breadboard area via various values of resistor, as described in the text.

Of drivers and receivers

For various reasons, special purpose buffers are used to send signals and receive signals on an RS232 line. These are called 'drivers' and 'receivers', and are exemplified by the National LM1488 and 1489 respectively. Figures 8 and 9 show a simplified view of how the driver output and receiver input look electrically.

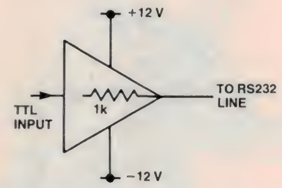


Figure 8. **Simplified view of an RS232 'driver' output.**

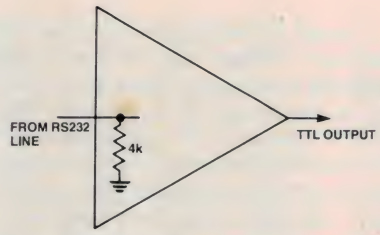


Figure 9. **An RS232 'receiver' looks like this electrically.**

The points to notice are that a receiver input looks like a (approximately) 4k resistor to ground. An operating driver output looks like a (approximately) 500 ohm resistor pulling up to 12 V (nominally), or pulling down to −12 V, according to its state.

Knowing these facts it is apparent that if a high or low signal is applied through a resistor to a receiver input or driver output, the resulting signal on the line (which can be monitored) will be high, low or in-between depending upon the value of resistor used.

Therefore, when looking at an unknown line, by applying the test oscillator's output via each resistor in turn, it is quickly possible to tell what that line does. The chart in Figure 10 details this. ▶

Parts List

Resistors .... ¼ W unless specified

R1	1k
R2	10k
R3, 4	2k
R5, 6, 17, 18	10M
R7, 8, 9, 10, 15, 16	10k
R11, 12	50k
R13, 14, 19, 20	680
R21	27k
R22	68k
R23	1M
R24, 25, 26, 27	100
R28, 29, 30, 31	300
R32, 33, 34, 35	1k
R36, 37, 38, 39	4k
R40, 41, 42, 43	100k
R44	1M

Capacitors

C1, 2	20u/20 V electrolytic
C3, 6, 7	0u1 tantalums
C4, 5	500u/25 V electrolytic

Diodes

D1, 2, 3, 4	1N914 or 1N4148 etc
ZD1, 2	2V7 small zener diode
BR1	Bridge rectifier, 50 PIV/1 A
LED1, 2, 3, 4	LEDs of your choice of colour

Transistors

Q1, 2, 3, 4	2N3906

Integrated circuits

IC1	LM339
IC2	LF356A
IC3	7812
IC4	7912

Transformer

T1	240 V primary, 12-0-12/500 mA secondary

Miscellaneous

Breadboard, case, fuse and holder, switch for power, power lead and plug etc.

Line Condition	Oscillator Signal via Resistor (ohms) 100k	4k	1k	300	100
Open	HL	HL	HL	HL	HL
Receiver Input	None	HL	HL	HL	HL
Driver Out-Low	L	L	L	FL/HL	HL
Driver Out-High	H	H	H	FH/HL	HL
Short to Ground	None	None	None	None	None
Short to +12 V	H	H	H	H	H
Short to −12 V	L	L	L	L	L

Charts shows the Level LEDs (not 'pulse' LEDs) activated in various cases.

H = High; L = Low; None = neither LED on; HL = alternating H and L; FL = Flashing Low; FH = Flashing High

Figure 10. **Chart showing how to test an unknown RS232 line, and the monitor's indications under various conditions.**

A word of warning is in order here however. Proper use of the monitor assumes that you at least know which pin on the connector is ground. This is almost always pin 7, so consistently in fact that we located the monitor's ground points on the breadboard opposite to the pins 7 of each of the two ribbon cables, and permanently left a small jumper installed at these two locations (see Figure 3). However, there are lurking about some units which don't abide by this standard. The only thing you can do about this (if you are documentationless and suspect this problem) is to open the case and actually trace the unit's circuit-board ground and see what DB25 pin it goes to.

Construction notes

The construction is not too critical. As can be seen the prototype version was built using Veroboard. One plan which is extremely useful to follow is to make a simple frame assembly like the one shown in Figure 11, which serves two purposes.

First it includes a flat clamp to grip the two ribbon cables (liberal use of double-sided wall-tile sponge adhesive tape also helps). Secondly, it keeps together the circuit board and the breadboard. In both these respects it makes wiring to the breadboard easier, and virtually eliminates any problems of wire breakage when the various parts are moved about during construction or testing of the project. As the photos show, the entire guts of the prototype can be removed in one piece, connected to the case only by the leads to the PSU.

Another hint: DON'T FORGET when soldering the ribbons to the breadboard that the numbering of the DB25 pins is *not* the same sequence as the ribbon cable conductors. This is shown in Figure 3.

Improvements

Although our troubleshooter has proved tremendously useful, I cannot claim that our prototype is the last word. In fact, I feel that if done again we would add several extra LEDs as simple on-off high-low indicators along with the existing level plus pulse monitor, so as to keep an eye on several lines at once. You may wish to adopt this idea in your unit. ●

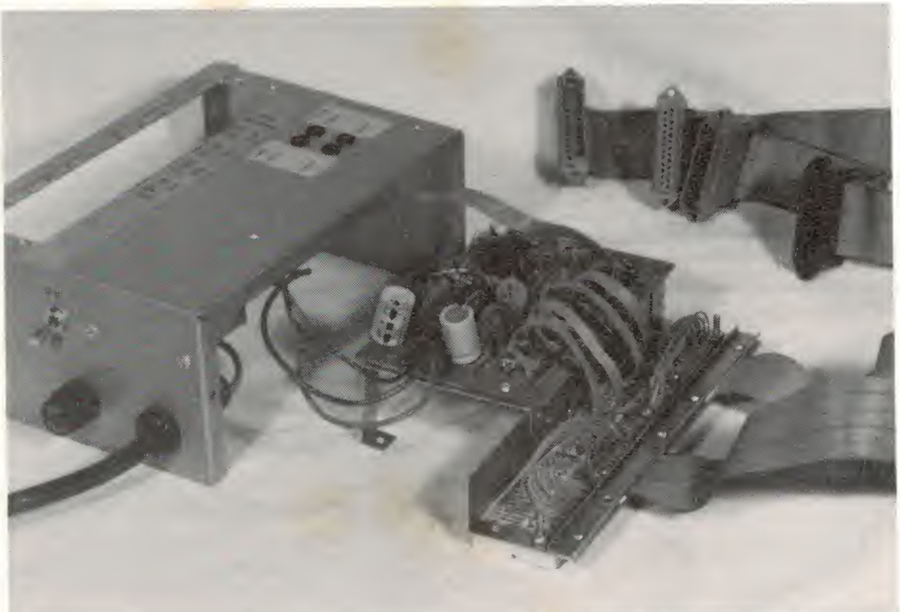


Figure 11. **When constructing a unit such as this, where there are a lot of wires hanging around, it's helpful to use brackets and cable clamps like the ones in this photo. They prevent undue strain on soldered connections, improving reliability, and enable the circuitry to come out of the box in one piece, more or less, for testing purposes during construction, or later if the unit needs repair.**

‘Prey’ — A predator/prey simulation for the Apple II

by Phil Cohen

The plotting capabilities of the Apple II are tremendous. Phil Cohen has used them for a bit of ‘modelling’ — simulating the way that different species interact when one is eating the other!

SIMULATION IS ONE of the most interesting abilities of the computer. Using just a machine and a little bit of imagination, you can ‘create’ whole worlds.

The program that I've developed makes use of the high-resolution graphics capabilities of the Apple — but I'm sure that anyone enthusiastic enough can modify it to run on almost any machine.

What it does is to build a ‘model’ of a little piece of territory. On this territory, there are two species of animal. They are called ‘predator’ and ‘prey’, and it is the delight of the predator species to catch and eat the prey.

Now the prey eats grass — and this grass grows in the territory with a particular yield per unit area (i.e: for any given square meter of territory, a certain number of kilograms of grass will grow each year). . . and so on.

What the program does (and I'll explain its operation in detail) is to build up a set of equations which tell the computer what the relationship between, say, the amount of grass and the birth rate of the prey is. So the computer can then tell you the answer to questions like ‘What will happen if the grass yield per unit metre falls by half?’ (this could be caused by blight or drought).

What the computer does is to produce a graph which shows, over a ten year period, what the population level of both the prey and the predators (shown as a dotted line) will be. The program allows you to alter a number of things at the start of the run, and will also allow you to put in a ‘crisis’ — a sudden change in one of the variables — at any time during the ten years. ▶

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The model
There are a number of variables set up at the start of the run.

Territory size
This is the amount of land on which both the predators and the prey live. Program variable: TR.

Prey population
The total number of prey on the territory. Program variable: P1.

Predator population
The total number of predators. Program variable: P2.

Food yield per unit area
This is the amount of grass (prey food) grown per square metre of the territory. Program variable: YD.

Prey natural life span
This is the number of years that one of the prey species will live if it doesn't get eaten. Program variable: L1.

Predator natural life span
This is the life span of each member of the predator species. Program variable: L2.

Prey cull losses
Basically, this is a measure of how many of the prey are killed by man. Program variable: CU.

Of these variables, only the predator and prey population levels will be changed by the program in the normal course of events. (Any of them can be changed by using the 'crisis' input — but I'll come to that later.)

The program, given this information, will go on to calculate the state of play at the end of each period (one period representing roughly two weeks). It does this by applying a number of equations — I'll go through these one by one.

Number of kills
This is the number of prey that is killed and eaten by the predators. The program calculates this by calculating the probability that one of each species will be at the same spot at the same time. So the number of kills is equal to the predator population times the prey population divided by the territory size. The mathematicians amongst you will notice that this is not actually the probability, and the naturalists will notice that there are a few other factors to be considered — but this is only a rough model.

Food available
The program multiplies the territory size by the yield and comes up with a total amount of grass grown in the period. No attempt has been made to properly quantify any of the variables in this model.

Number of prey births
This is calculated by taking the amount of grass, dividing by the number of prey, and then limiting it to 25% of the original population.

Number of predator births
Similarly, the number of predator births is proportional to the amount of food for that species (in their case, the number of prey killed) — and again, it is limited to 25% of the original population.

Number of natural deaths
The number of births is subtracted from the total population (which assumes no infant mortality) and the whole thing is divided by the life span.

Predator and prey populations
Each of the factors (births, deaths, etc) are either added to or subtracted from the original population to give the new populations.

Having finished doing all of the calculations, the program will simply plot the predator and prey populations on the screen, and then start all over again, giving a total of 240 steps in 10 years. To do this sort of thing by hand would take some weeks — but the computer manages it in about a minute!

How it works

The first few lines of the program initialise the variables, and then the screen is cleared (lines 10 — 60). Then the program prints out the current state of all of the variables, and asks whether you want to alter any of them before the run (lines 70 — 360).

You can alter any or all of them at this stage, and the program will print out the current state each time. If you enter a '9', the program takes this as a signal that you are satisfied with the initial state of the variables, and goes on to the next part.

This asks you for the 'crisis' input — that is, a sudden change in one of the variables at a particular point in the run. So for example, you can cause the prey population to drop to half its usual value at year 5 (this could be due to disease, etc).

Line 410 translates the 'crisis' year into a position across the screen.

Line 470 sets the machine into HGR mode — that is, with most of the screen in high-resolution graphics mode, and with a small 'text window' at the bottom, for displaying messages.

The next few lines (490 — 530) put the base line onto the graph. This represents zero population in either species, and has breaks in it to show the years (10 in all).

Then the calculations start in earnest, as I listed above, at lines 580 — 830.

By the time the program reaches line 850, the values for P1 (prey population) and P2 (predator population) have been worked out, and are ready for plotting.

The next section to line 900 plots the prey population as a solid line. The variable OY holds the last value plotted, and HPLOT is used to ensure that the line really is solid — if I had just put the point onto the screen, then sudden changes would cause a break in the plot. This way, it's solid all the way.

Then the predator population is plotted. I've used a dotted line for this — and to increase readability I've had the program HPLOT from a point under the point to be plotted to a point over it. So statement 940 plots a short vertical segment every third plotting position across the screen.

Now all that remains is to make the 'crisis' change if we're in the right year. Line 960 checks the year, and lines 980 — 1070 make the change, and print the fact on the screen (in the text window). The previous value of the altered variable is printed too.

Line 1080 checks for the end of the run, and passes control to a 'pause' statement at line 1120, so that you can have a good look at the results.

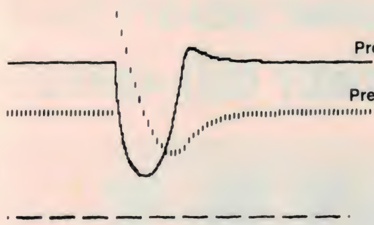
When the plot is finished, all you have to do is to press RETURN and the program will start again, but with the variables set the way they were when the run finished. If you want to re-initialise the variables, you'll have to break the program and re-RUN it.

Sample runs

Figure 1 shows a sample run. I left the variables set up the way they were initialised, and put in a change in predator population at year 3. In year 3, the predator population changed from 75 to 150. This could be due, for example, to problems in other areas forcing an influx of predators all of a sudden.

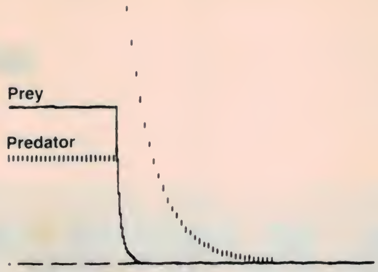
```
1 SIZE OF TERRITORY            500

2 PREY POPULATION              100

3 PREDITOR POPULATION          75

4 FOOD YIELD PER UNIT AREA     15

5 PREY NATURAL LIFE SPAN       10

6 PREDITOR NATURAL LIFE SPAN 20

7 PREY CULL LOSSES             1


WHICH WOULD YOU LIKE
TO ALTER (9 = FINISHED) ? 9

YEAR FOR CHANGE (0 - 10) ? 3
WHICH VARIABLE TO CHANGE (1 - 7) ? 3
VALUE TO BE SET AT YEAR 3 ?150
```

Figure 1(a). **Sample run. Change in predator population at year 3.**



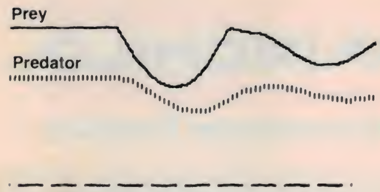
YEAR 3 PRED 75 -> 150

Figure 1(b). **Doubling the predator population causes a fast drop in the prey population.**



YEAR 3 PRED 75 -> 250

Figure 2. **Predator population increased even further.**



YEAR 3 CULL 1 -> 7

Figure 3. **Prey population culled.**

The plot shows the prey population (solid line) and the predator population (dotted line). The change doubles the predator population, which causes a fast drop in the prey population due to increased number of kills. However, as soon as the number of prey starts to drop, starvation of the predators makes their population drop too. In fact, it will drop (at the end of year 5) to below its normal value. This drop in the predator population will cause the prey population to go back up, but its overshoot is limited by food availability, and so it quickly settles down. By the end of the 10 year period of the run, things are back to normal again.

However, interesting things start to happen when you increase that 'crisis' blow. In Figure 2 I've increased the predator population even further. So far, in fact, that there are enough predators to completely kill out the prey population. Naturally, when there are no prey, the predators die out too.

An interesting thing happens if you put in a proportion of 'cull' (i.e: killing of the prey at a constant rate, by humans, say). Figure 3 shows this. If the intention of the cull was to reduce the prey population (perhaps to reduce crop losses), then the cullers would be surprised to see that three years after the cull started, the prey population was slightly more than its initial value, due to the dynamic effects of the predator population!

Suggestions for further work

The possibilities of this sort of thing are endless. Naturally, the model I've used here could be extended (one rather obvious extension would be to put names to the two species, and to try to model a real system).

But there are other directions in which the thing can move — what about introducing seasonal variations in birth rate, food yield, hunting capabilities, etc?

There's even the possibility of making the whole thing two-dimensional. Break the territory up into a number of areas, and see what happens when a change is introduced into one area. ●

'PREY' — SIMULATION FOR THE APPLE II

```
10  REM  FIRST, INITIALISE THE VARIABLES TO THEIR STARTING VALUES
20 TR = 500:P1 = 180:P2 = 75:YD = 15
30 L1 = 10:L2 = 20:CU = 1
40  TEXT
50  REM  NOW CLEAR THE SCREEN (THE HARD WAY, TO CATER FOR ALL TERMINALS)
60  FOR I = 1 TO 30: PRINT : NEXT I
70  PRINT "1 SIZE OF TERRITORY"; TAB( 30);TR
80  PRINT
90  PRINT "2 PREY POPULATION"; TAB( 30); INT (P1)
100  PRINT
110  PRINT "3 PREDITOR POPULATION"; TAB( 30); INT (P2)
120  PRINT
130  PRINT "4 FOOD YIELD PER UNIT AREA"; TAB( 30);YD
140  PRINT
150  PRINT "5 PREY NATURAL LIFE SPAN"; TAB( 30);L1
160  PRINT
170  PRINT "6 PREDITOR NATURAL LIFE SPAN"; TAB( 30);L2
180  PRINT
190  PRINT "7 PREY CULL LOSSES"; TAB( 30);CU
200  PRINT : PRINT
210  REM  THE NEXT PART OF THE PROGRAM ALLOWS YOU TO CHANGE THE STARTING
220  REM  CONDITIONS BY ALTERING ANY OR ALL OF THE VARIABLES
230  PRINT "WHICH WOULD YOU LIKE"
240  INPUT "TO ALTER (9 = FINISHED) ? ";A
250  PRINT
260  ON A GOTO 300,310,320,330,340,350,360,60,390
270  REM  I DIDN'T USE A STRING ARRAY HERE BECAUSE IT WOULD HAVE MADE THE
280  REM  REST OF THE PROGRAM DIFFICULT TO READ - ALL OF THE EQUATIONS
290  REM  WOULD HAVE BEEN IN TERMS OF ARRAY ELEMENTS
300  INPUT "TERRITORY SIZE ? ";TR: GOTO 60
310  INPUT "PREY POPULATION ? ";P1: GOTO 60
320  INPUT "PREDITOR POPULATION ? ";P2: GOTO 60
330  INPUT "FOOD YIELD PER UNIT AREA ? ";YD: GOTO 60
340  INPUT "PREY NATURAL LIFE SPAN ? ";L1: GOTO 60
350  INPUT "PREDITOR NATURAL LIFE SPAN ? ";L2: GOTO 60
360  INPUT "PREY CULL LOSSES ? ";CU: GOTO 60
370  REM  THE NEXT PART OF THE PROGRAM ALLOWS YOU TO 'INJECT' A CHANGE IN
380  REM  ANY OF THE VARIABLES AT ANY POINT IN THE RUN
390  INPUT "YEAR FOR CHANGE (0 - 10) ? ";YR
400  REM  YX IS THE POSITION ON THE SCREEN WHICH CORRESPONDS TO THAT YEAR
410 YX =  INT (24.2 * YR)
420  INPUT "WHICH VARIABLE TO CHANGE (1 - 7) ? ";V%
430  IF V% > 7 OR V% < 1 THEN  GOTO 420
440  PRINT "VALUE TO BE SET AT YEAR ";YR;" ";
450  INPUT VL
460  PRINT : PRINT : PRINT
470  HGR
480  REM  PUT THE BASE LINE ONTO THE SCREEN (WITH A GAP FOR EACH YEAR)
490  HPLOT 0,159
500  FOR I = 3 TO 242 STEP 22
510  HPLOT  TO I - 3,159
520  HPLOT I + 3,159
530  NEXT I
540  REM  X IS THE CURRENT POSITION ACROSS THE SCREEN
550 X = 0
560  REM  START GRAPH
570  REM  KL IS THE NUMBER OF KILLS MADE BY THE PREDITORS
580 KL = (P1 * P2) / TR
590  REM  FD IS THE AMOUNT OF FOOD AVAILABLE TO THE PREY
600 FD = TR * YD
610  REM  THE NEXT STATEMENT ENSURES THAT THERE WILL BE NO BIRTHS IF
620  REM  THERE IS NO POPULATION!
630  IF P1 = 0 THEN B1 = 0: GOTO 670
640 B1 = FD / P1
650  REM  THE NEXT STATEMENT LIMITS THE BIRTH RATE TO A PERCENTAGE OF THE
660  REM  CURRENT POPULATION
670  IF B1 > P1 / 4 THEN B1 = P1 / 4
680  REM  THE PREDITOR BIRTH RATE IS PROPORTIONAL TO THE NUMBER OF KILLS
690 B2 = 10 * KL / P2
700  IF B2 > P2 / 4 THEN B2 = P2 / 4
710  REM  M1 AND M2 ARE THE NATURAL MORTALITY RATES FOR THE TWO SPECIES
720 M1 = (P1 - B1) / L1
730 M2 = (P2 - B2) / L2
740  REM  THE NEW PREY POPULATION IS THE OLD ONE MINUS THE NUMBER OF
750  REM  NATURAL DEATHS, MINUS THE NUMBER OF PREDITOR KILLS, PLUS
760  REM  THE NUMBER OF BIRTHS, AND MINUS THE AMOUNT OF 'CULL' BY HUMANS
770 P1 = P1 - M1 - KL + B1 - CU
780  REM  THE NEW PREDITOR POPULATION IS THE OLD ONE MINUS NATURAL DEATHS
790  REM  PLUS BIRTHS
800 P2 = P2 - M2 + B2
810  REM  NOW MAKE SURE BOTH FIGURES ARE SENSIBLE
820  IF P1 < 0 THEN P1 = 0
830  IF P2 < 0 THEN P2 = 0
840  REM  NOW WORK OUT THE VERTICAL POSITION FOR THE PREY POPULATION PLOT
850 Y = 159 - (.5 * P1)
860  IF Y < 0 THEN Y = 0: IF Y > 159 THEN Y = 159
870  IF X = 0 THEN  GOTO 900
880  REM  HPLOT FROM THE LAST POSITION TO THIS ONE
890  HPLOT X - 1,OY: HPLOT  TO X,Y
900 OY = Y
910  REM  NOW DO THE SAME FOR THE PREDITORS
920 Y = 159 - (.8 * P2)
930  REM  THE NEXT STATEMENT WILL GIVE A DOTTED LINE FOR THE PREDITORS
940  IF Y > 1 AND Y < 158 AND  INT (X / 3) = X / 3 THEN  HPLOT X,Y - 1: HPLOT
      TO X,Y + 1
950 X = X + 1
960  IF X <  > YX THEN  GOTO 1080
970  REM  NOW DO THE CHANGE THAT WAS REQUESTED
980  PRINT "YEAR ";YR;" ";
990  ON V% GOTO 1000,1010,1020,1030,1040,1050,1060
1000  PRINT "TERR ";TR;:TR = VL: GOTO 1070
1010  PRINT "PREY "; INT (P1);:P1 = VL: GOTO 1070
1020  PRINT "PRED "; INT (P2);:P2 = VL: GOTO 1070
1030  PRINT "YIELD ";YD;:YD = VL: GOTO 1070
1040  PRINT "PREY SPAN ";L1;:L1 = VL: GOTO 1070
1050  PRINT "PRED SPAN ";L2;:L2 = VL: GOTO 1070
1060  PRINT "CULL ";CU;:CU = VL
1070  PRINT " -> ";VL;" ";
1080  IF X < 242 THEN  GOTO 560
1090  REM  THE NEXT STATEMENT INPUTS A 'DUMMY' VARIABLE TO KEEP THE
1100  REM  CURSOR ON THE SCREEN SO THAT YOU CAN VIEW THE FINAL PLOT
1110  REM  BEFORE STARTING AGAIN
1120  INPUT " ";A$
1130  GOTO 40
```

Use your Motorola 6800 D2 kit to progam 2716 EPROMs

If you have been waiting for cheap, easy to program and easy to use EPROMs before incorporating non-volatile memory into your microcomputer system or building dedicated microprocessor projects, then you need wait no longer. With the 2716-type EPROMs now available and this very simple interface you can program EPROMs very quickly and cheaply using a Motorola 6800 D2 kit.

David L. Craig.

OVER THE PAST couple of years there has been a remarkable development in the EPROMs available for use in microprocessor systems. After the difficult-to-program 1702 EPROMs with 512 x 8 storage, we saw the 2708 EPROM arrive with twice the storage capacity (1024 x 8 bits) and considerably simpler programming requirements. The 2708 has become relatively cheap, but many hobbyists have probably been put off using this device because it requires three power supply voltages (+12 V, +5 V, −5 V) when the rest of the microprocessor system probably only uses one (+5 V); it also requires a programmer capable of switching a +26 V programming supply, and it requires each location to be programmed about 100 times in a loop, making programming of individual locations difficult.

Now we have the 2716, which makes EPROMs much more attractive to hobbyists. It contains 2K x 8 bits of storage, uses only a single +5 V power supply, requires a static +25 V programming supply, with each location being programmed with a single 50 ms TTL-level pulse, and allows programming of any number from 1 to 2048 locations at a time. And best of all is the price — around $5 each in one-off quantities from some sources. This represents far better value than the 2708 ever did.

2716 EPROMs can be programmed using a Motorola 6800 D2 kit and the very simple and low-cost interface circuit shown in Figure 1. The programmer interface connects to the user PIA (Peripheral Interface Adaptor) of the D2 kit. A programming power supply of

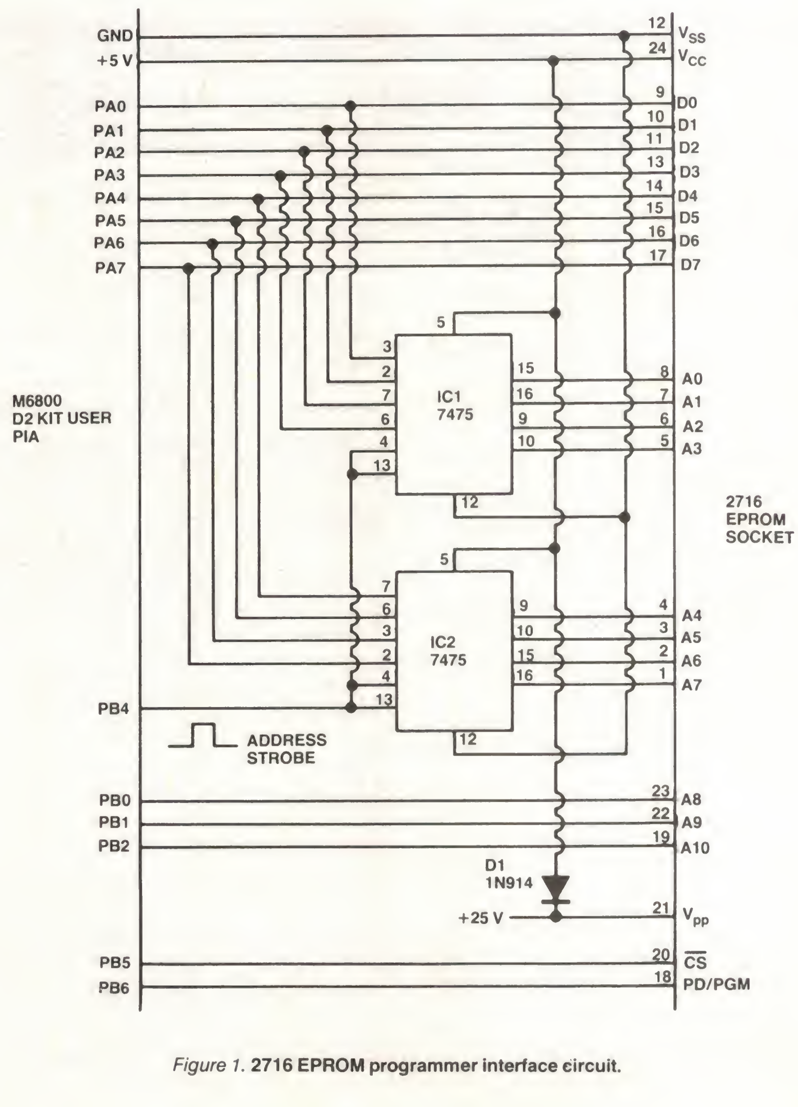


Figure 1. **2716 EPROM programmer interface circuit.**

+24 V to +26 V is also required. The interface circuit simply uses two 7475 quad latch ICs to latch the address information from the PIA, and one diode to feed +5 V to the Vpp pin of the 2716 with the +25 V programming supply turned off. No pc board layout is given since the circuit is so simple and the method of construction will depend on the system with which the interface is to be used.

All the signal generation and timing required are handled by a software routine called 'PG2716', for which a full listing is given. The routine latches the address of the location to be programmed into the 7475s, then reads the contents of that location, checking that it is erased (i.e: $FF), programs the location and then again reads the contents to verify the programmed data. Each address of the EPROM is programmed in turn in this way. The waveforms required by the 2716 for this sequence are shown in Figure 2. Using these waveforms and the comments in the listing the operation of the routine should be fairly easily followed. The routine occupies only 170 bytes of memory, and while the listing shows it assembled beginning at location $1E00, it is relocatable without changes. The only fixed locations used are $A002-A005 and $A042-A043, which are in the D2 kit stack RAM.

The principle of operation of the programmer is that the data to be stored in the EPROM is first loaded into RAM and then copied as a block into the EPROM. The only restriction on loading the data into RAM is that the eleven low-order address bits (A0-A10) of the data in RAM must correspond to the address in the EPROM at which that data byte is to be stored; i.e: a 2K x 8 block of data in the D2 kit RAM maps directly to the 2716 EPROM.

The sequence of steps to be followed in using the programmer is:

a. connect the interface circuit to the D2 kit
b. insert the EPROM into the interface socket
c. power up the D2 kit
d. load the programmer program and the data to be programmed into the D2 kit memory
e. power up the +25 V programming supply
f. enter the beginning address of the data in the D2 kit memory into $A002-3, and the end address into $A004-5 via the D2 kit keyboard (note that any number of data bytes from 1 to 2048 can be specified.)
g. start the programmer by entering $1E00 G via the D2 kit keyboard
h. if the EPROM is programmed successfully, the JBUG prompt '-' will appear on the D2 kit display after approximately 100 seconds
i. power down +25 V programming supply
j. power down D2 kit

The EPROM is then programmed ready for use.

In the event of an error, a software interrupt of the programming routine will occur.

a. if the SWI occurs at $1E33, the EPROM was not correctly erased
b. if the SWI occurs at $1E34, programming did not occur correctly

In either case, after the SWI, X = location at which failure occurred, A = data expected at failed location, B = data in EPROM at failed location.

2758 (1K x 8 bit) EPROMs can also be programmed with this programmer. 2758 EPROMs are 2716 EPROMs with only the lower or upper half working. To program a 2758, load the data to be programmed into the appropriate half of a 2K x 8 block in the D2 kit RAM so that the 1K x 8 data maps directly into the working half of the 2K x 8 locations in the 2758.

One note of warning should be given for purchasers of 2716-type EPROMs. Some manufacturers, e.g: Texas Instruments, have designated a three power supply 2K x 8 EPROM with the 2716 code (e.g: TMS 2716). Be careful to purchase the single power supply version — from Texas this is the TMS 2516.

A place suitable for using 2716 EPROMs, though it is not mentioned in the manual, is in the two sockets on the main D2 kit board provided for optional PROMs. The straps on the board necessary for 2716 use are E0-E4, E1-E2, E3-E7 and E5-E9. All other connections on the pc board are correct. Wherever it is that you use 2716 EPROMs, one thing is certain — you will never go back to 2708s.

The principle of using a programmable input-output port with a single interface to program 2716 EPROMs could easily be applied to microprocessor systems using other processors, e.g: Z80, 8080, etc. It can also be applied to programming other EPROM types, and the author has built such an interface for Intersil IM6654 512 x 8 bit CMOS EPROMs.

(Ref. 'An Ultra-Low-Cost Programmer for CMOS EPROMs', Electronic Engineering (UK), Jan. 1981, pp 23-25.) ▶

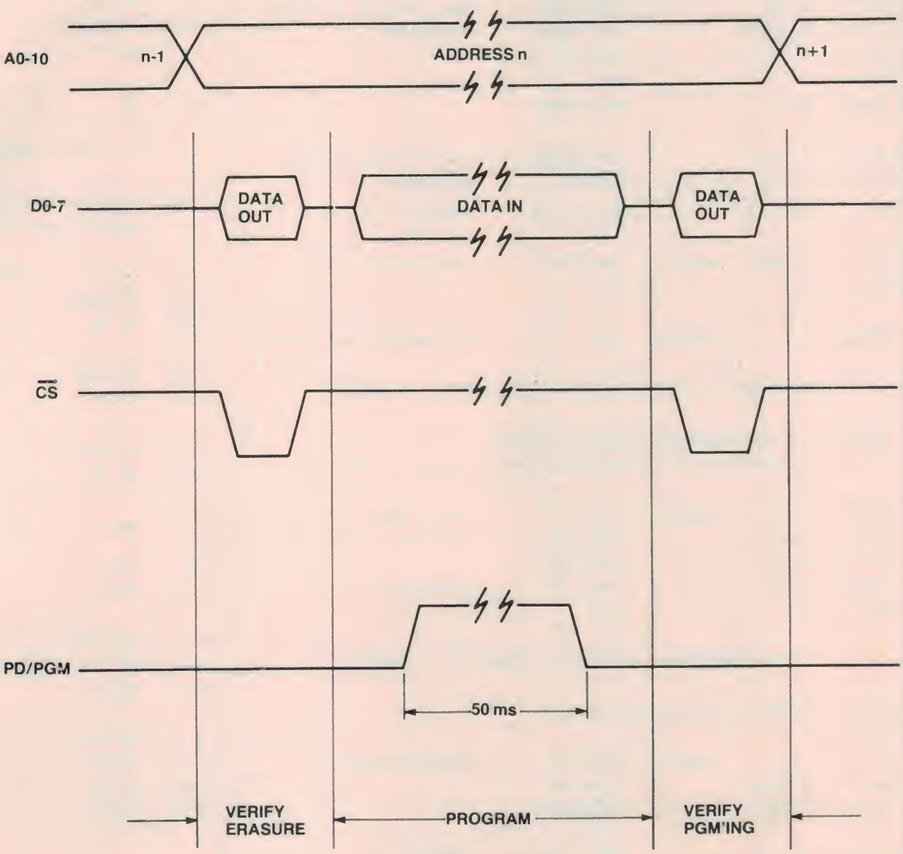


Figure 2. **2716 EPROM programmer waveforms.**

Program Listing

```
                ** 2716 EPROM PROGRAMMER PROGRAM **

       8004     PIAA     EQU $8004      User PIA
       8005     PIACRA   EQU $8005
       8006     PIAB     EQU $8006
       8007     PIACRB   EQU $8007

A002            BEGADD   RMB2           From begin address
A004            ENDADD   RMB2           From end address

A042            ADDPNT   RMB2           Pointer at address to be
                                        read or programmed

1E00   C6 FF    PG2716   LDAB #$FF      Set PIAB as outputs
1E02   CE 8006           LDX #PIAB
1E05   8D 31             BSR PIASET
1E07   C6 20             LDAB #$20      Initialize PIAB
1E09   E7 00             STAB 0,X

1E0B   FE A002           LDX BEGADD     Initialize ADDPNT
1E0E   09                DEX
1E0F   08       LOOP     INX
1E10   FF A042           STX ADDPNT     Update pointer

1E13   8D 33             BSR OUTADD     Output address

1E15   8D 53             BSR DATARD     Read data and
1E17   86 FF             LDAA #$FF
1E19   11                CBA            verify EPROM
1E1A   26 14             BNE ERROR1     location erasure

1E1C   8D 66             BSR DATAWR     Program EPROM location

1E1E   8D 4A             BSR DATARD     Read location to verify
1E20   FE A042           LDX ADDPNT     programming
1E23   A6 00             LDAA 0,X
1E25   11                CBA
1E26   26 0C             BNE ERROR2

1E28   8C A004           CPX ENDADD     Test if all locations
1E2B   26 E2             BNE LOOP       programmed
1E2D   7E E08D           JMP RESTAR     Return to JBUG

1E30   FE A042  ERROR1   LDX ADDPNT     Not properly erased
1E33   3F                SWI

1E34   3F       ERROR2   SWI            Not properly programmed

   ** SUBROUTINE TO SET PIA LINES AS INPUTS OR OUTPUTS **

Entry - X = PIA peripheral register address
        B = required data direction pattern  (0 = in, 1 = out)

1E38   6F 01    PIASET   CLR 1,X        Access DDR
1E3A   E7 00             STAB 0,X       Set lines as I/O
1E3C   86 04             LDAA #$04
1E3E   A7 01             STAA 1,X       Access PR
1E40   39                RTS

        ** SUBROUTINE TO OUTPUT ADDRESS TO EPROM **

Entry - ADDPNT  =  address to be output

1E48   C6 FF    OUTADD   LDAB #$FF      Set PIAA as outputs
1E4A   CE 8004           LDX #PIAA
1E4D   8D E9             BSR PIASET

1E4F   B6 A043           LDAA ADDPNT+1  Output low byte
1E52   A7 00             STAA 0,X       to PIAA
1E54   B6 A042           LDAA ADDPNT
1E57   84 07             ANDA #$07      Mask off high 5 bits
                                        of high byte
1E59   8A 10             ORAA #$10
1E5B   E6 02             LDAB 2,X       Output high 3 bits
1E5D   C4 E0             ANDB #$E0      of address to PIAB
1E5F   1B                ABA            and output low
1E60   A7 02             STAA 2,X       byte into latches by
                                        setting address strobe
                                        high
1E62   86 EF             LDAA #$EF      Set address strobe low
1E64   A4 02             ANDA 2,X       to latch address

1E66   A7 02             STAA 2,X
1E68   39                RTS

          ** SUBROUTINE TO READ DATA FROM EPROM **

Entry - address latched
Exit  - data in B

1E6A   5F       DATARD   CLRB           Set PIAA as inputs
1E6B   CE 8004           LDX #PIAA
1E6E   8D C8             BSR PIASET

1E70   86 DF             LDAA #$DF      Set PB5 low to read
1E72   A4 02             ANDA 2,X       data
1E74   A7 02             STAA 2,X

1E76   E6 00             LDAB 0,X       Read data

1E78   86 20             LDAA #$20      Set PB5 high to end
1E7A   AA 02             ORAA 2,X       data read
1E7C   A7 02             STAA 2,X

1E7E   39                RTS

          ** SUBROUTINE TO WRITE DATA TO EPROM **

Entry - address latched
      - ADDPNT points to data

1E84   C6 FF    DATAWR   LDAB #$FF      Set PIAA as outputs
1E86   CE 8004           LDX #PIAA
1E89   8D AD             BSR PIASET

1E8B   FE A042           LDX ADDPNT     Point to data
1E8E   E6 00             LDAB 0,X       Fetch data

1E90   CE 8004           LDX #PIAA
1E93   E7 00             STAB 0,X       Output data

1E95   86 40             LDAA #$40      Set PB6 high for

1E97   AA 02             ORAA 2,X       50ms to program
1E99   A7 02             STAA 2,X       EPROM location

1E9B   CE 0F00           LDX #$0F00     50ms delay
1E9E   09       DLY50    DEX
1E9F   26 FD             BNE DLY50

1EA1   CE 8004           LDX #PIAA      Set PB6 low to end
1EA4   86 BF             LDAA #$BF      programming pulse
1EA6   A4 02             ANDA 2,X
1EA8   A7 02             STAA 2,X

1EAA   39                RTS
```

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Whereas ordinary detergent and water may only clean the surface, Glo-Wash removes stubborn road grime that would otherwise become ingrained and cause your paintwork to rapidly deteriorate.

And if you want to give your car extra special protection, The Kitten System brings you Wash-n-Wax. Wash-n-Wax is the blend of specially developed high quality cleaning agents and waxes that protects as it waxes your car's body.

But the beauty of both Wash-n-Wax and Glo-Wash is their wash-on/hose-off simplicity; there's no need to chamois anymore. And a good looking body won't cost you an arm and a leg: a bottle of Wash-n-Wax or Glo-Wash will wash the average car at least 17 times.

So for a good looking body, use Glo-Wash or Wash-n-Wax from The Kitten System at least once a week.

THE KITTEN SYSTEM.

KIW 311/1

THE CREAM OF CAR CARE

Exclusive to Marantz. Very sophisticated. Very superior. Very expensive.

Very high fi indeed.

These Marantz Gold components represent the world's most advanced, most inspired, most stringently tested and sophisticatedly engineered audio equipment.

For the wealthy—exclusive toys.

For the connoisseur — the finest hi-fi money can buy.

The Marantz TT1000 (around $2500), with its precision-made high density glass and golden aluminium sandwich structure, is justifiably described as one of the most beautiful turntables ever.

'Playing a series of direct-recorded discs, warped discs, discs with nasty low frequency content and discs requiring unusual trackability performance, showed clearly that this system borders on the superlative in areas where even most good turntables only provide good to above average performance.'

SM1000

'. . .the resonance characteristics of the TT1000 are the lowest we have yet seen from any turntable irrespective of its selling price.'

'This is top-of-the-line equipment for people who rate hi-fi as their greatest pleasure in life'. — *Louis Challis, Electronics Today International, April 1981.*

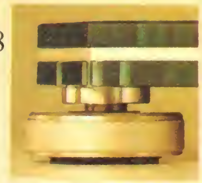
Similarly, the Marantz SM1000 Stereo Amplifier (around $5000) is designed to be the ultimate in luxury and performance.

When it was bench-tested by ETI Magazine in an exhaustive lab study, Louis Challis stated 'The Marantz SM1000 Amplifier has the capability to provide superlative performance at home, in a laboratory, in a studio, or in a rock band with the ease and panache of a professional.

'The power output claims are modest for the unit is readily capable of producing 625 watts into an 8 ohm load with both channels driven . . .'.

And when the Marantz ST8 FM/AM Tuner (around $700) was put through its paces so technically surprising was its performance that a second series of tests was devised to check the first results.

'As a result . . . the Marantz ST8 . . . far ahead of any tuner we have ever measured and better than any tuner we have ever seen reviewed in any other magazine, either local or overseas.' — *Paul de Noskowski, Electronics Australia, April 1981.*



The TT1000's adjustable, high-absorption air suspension audio insulator feet.

Marantz Gold. The New Audio Standard.

ST8

Detailed specifications of these exclusive Marantz Gold components are available on request by writing to:

Marantz (Australia) Pty. Limited,
19 Chard Road, Brookvale, NSW 2100
Phone (02) 939 1900 Telex AA24121
Melbourne (03) 544 2011
Brisbane (07) 44 6477
Adelaide (08) 223 2699
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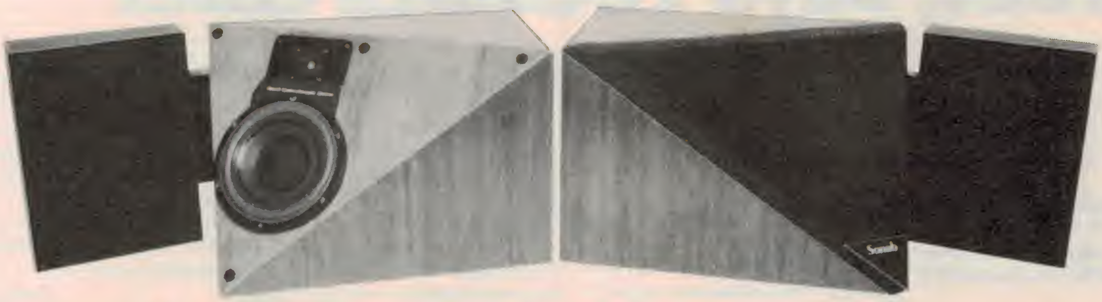
ELECTRONIC LIFESTYLE



Sonab is back!

It's true. Not a word of a lie. Holders of the Sonab name in Australia, Concept Audio, have 'resurrected' the name with the release of a new Stig Carlsson product.

Sonab of Sweden Pty Ltd was established in 1972 to market in Australia the now-famous Carlsson loudspeakers plus Sonab-branded amplifiers, turntables and cassette decks.

In 1977, due more to politics than to economics, the Swedish-based parent company closed down. Service on all Sonab products however was maintained and has been to this day by Concept Audio Pty Ltd.

Concept have delightedly announced that Stig Carlsson has designed a new product to be known as the OA.51 Ortho-Acoustic Loudspeaker System. This system is now available throughout Australia under the Sonab name through a limited number of specialist hi-fi outlets.

The speaker is designed to be wall-mounted or to stand on a bookshelf and has a recommended retail price of $1100. The sound quality is superb — typically Sonab inasmuch as it offers a very open, clean and detailed sound, according to Concept.

Details from Concept Audio, 22 Wattle Rd, Brookvale NSW 2100. (02)938-3700.

Going the National 'Way'

National have just released what they claim is 'the world's smallest, lightest, highest performance, easiest to operate' stereo cassette recorder, called the 'Way'.

The player measures 75 mm wide by 108 mm high by 28 mm deep and weighs only 223 grams without batteries.

The Way's compact dimensions arise from the use of a specially-fabricated flexible printed circuit board, a Matsushita engineering development. This fits neatly over the tape transport system which features a high-torque rare-earth magnet coreless dc motor, high quality drive belt, and an anti-rolling mechanism to assure rotational stability when listening on the move. (Matsushita is National's parent company.)

The head is secured by stainless steel support, assuring excellent tape-to-head contact and optimum alignment. For fast-forward and rewind, a special assembly moves forward around the tape to push the pressure pad away from the tape, thereby avoiding abrasion of the head or tape. A hyperbolic head is employed to further improve tape-to-head contact while reducing the contour effect and improving low-range reproduction, National say.

The Way is produced in three styles, though all have the same features. Play and stop buttons are located on top and require only a gentle tap to activate. Large, lockable fast-forward and rewind buttons are located on the cassette lid; switching is accomplished via the reel table spindles, so the buttons are flat and do not protrude.

Even when the unit is in its supplied belt holder, the user can change cassettes and operate all controls with one hand. A three-position tape eq/tone selector gives the user a choice of response characteristics for normal and metal cassette reproduction.

The open-air stereo headphones supplied with the player have the cord attached to only one side. Built into the cord is a remote pause button which, in locked position, also turns the power off to reduce battery drain. Two stereo headphone jacks are incorporated.

Other features include LED battery indicator, auto-stop, dc-in jack, and external battery adaptor.

Quoted frequency response is 30 Hz to 14 kHz on normal tape, 30 Hz to 15 kHz on metal tape. Fast-forward and rewind time is given as 120 seconds with C60 tape. The unit is powered from two 1.5 V cells. Type AA cells fit within the unit, but for longer playing times, a separate battery pack taking D-size cells is included.

The unit was due for release in August and should be generally available in September. Further details from National Panasonic, 95-99 Epping Rd, North Ryde NSW 2113.

Beyer dynamic microphone

Beyer have released their new M300N(C) microphone, similar in design to the widely used model M400.

Rank Electronics claim that the M300 is a good quality microphone with a stainless steel basket and is intended to stand up to the rigours of road use.

It is a pressure gradient microphone with a very low feedback and its capsule suspension significantly reduces body noises. The M300 has a cardioid pattern and a wide frequency response of 50-15 000 Hz. It is supplied with a 7.5 m Switchcraft cable and clamp.

For further information please contact Rank Electronics, 16 Suakin St, Pymble NSW 2073. (02)449-5666.

Bring sanity back to hi-fi market, says Technics chief

In Japan late in June, Technics Marketing chief Peter Lee, told a dealer/editorial seminar that hi-fi sales would remain depressed for a while, but despite price cutting and dumping, Technics were committed to bringing sanity back to the marketplace.

"The immediate future is grim," Lee said. "But those who survive the current economic depression will be the leaders in the future."

He said that consumer dollars are going into video, and that the situation for the hi-fi industry is made worse by high interest rates that make it difficult for dealers to commit to stock. High home loan interest rates were also taking money out of the consumer market that would otherwise be spent on hi-fi.

This has created problems in the hi-fi industry and manufacturers have been dumping stock since last October. This has put new low price points on hi-fi and in an attempt to meet these new low prices points the industry is being forced from hi-fi down into low-fi.

Lee told dealers that Technics, although committed to a bigger involvement in the market place, was pledged to try and bring sanity back to hi-fi retailing. Technics plans to attack the market in the next two years on a number of fronts.

At the June Technics dealer/audio conference the areas of attack were mapped out.

The main thrust will be in 'new wave' audio. This is compact hi-fi and portable hi-fi for outdoor music, plus component, system, audio visual, and deck-receivers for indoors.

This 'new audio' is breaking into, and is expected to eventually take over, the music centre and system markets. The portable hi-fi will be large portables, while the compact hi-fi is the Walkman type hip stereo using headphones. 'Stereo to go', as come people call it.

Although Technics sees the audiovisual area becoming an important market in coming months it doesn't anticipate entering this market for some time, other than to supply tuners and video control centres for hi-fi/video systems.

There are no plans for a Technics video recorder or high quality TV monitor, a move which many consumers and retailers would doubtless welcome.

Dennis Lingane

This three-component range from Technics comprises an integrated amplifier, tuner and graphic equaliser measuring only 315 mm wide which 'plug in' to each other — no more cables. These are to be released into the 'new audio' area, where compactness, versatility and value for money are important.

Matsushita and Ampex get together on video tape

Matsushita Electric Industrial Co of Japan recently announced that their 'M-format' half-inch video recording format for broadcast use had been adopted and developed by Ampex, a leading manufacturer of broadcasting video equipment.

The M-format professional video system employs a VHS half-inch video cassette and enables a single-unit configuration of camera/VTR combination for electronic news gathering (ENG) and electronic field production (EEP).

M-format is said to have superior picture quality and better portability over conventional three-quarter-inch formats, and two Japanese broadcasting equipment manufacturers, Hitachi Denshi and Ikegami, have already announced that they will be adopting the M-format system. They exhibited the systems at this year's National Association of Broadcasters' convention.

More from Milty

Concept Audio, the importers and distributors of Milty Products in Australia, have announced some new additions to their record-care range.

Firstly, following hot on the heels of the now-famous Permostat anti-static record treatment, is a product to be known as Permoclean. This is a fluid cleaner and the claim by the manufacturer is that it will clean a record as effectively as any professional record cleaning machine.

It is said to remove both organic and inorganic matters from the surface of a record together with the removal of micro-dust particles from the inner groove of the record.

A new pad has been developed, known as the Duo Pad. This will be used in both Permoclean and Permostat kits in future and is a double-sided buffing device.

The unique feature of the Duo Pad is that as surfaces become old and worn, replacement cartridges will become available — therefore allowing the Duo Pad to be used on a continuing basis at a very economical price.

The final new product to come into the Milty Products line-up is a rubber work mat. This mat, which comprises 55 000 tiny rubber tentacles, will hold a record firmly in position whilst Permostat and Permoclean are being applied. The mat can also be used when applying other record cleaning and treatment processes.

All products are expected to be at hi-fi shops and record bars in October. Enquiries to Concept Audio Pty Ltd, 22 Wattle Rd, Brookvale NSW 2100. (02)938-3700.

Fostex monitor

Fostex recently released the Model 6301 self-powered personal monitor.

This unit can be used to monitor signals from tape recorders to electric guitars, from synthesizers to amplifiers.

The use of the 6301's 10 watt amplifier is available when no other power service exists.

The compact size: 188 x 120 x 118 mm and its weight of only 3.2 kg make this unit very versatile.

Frequency response is quoted as 80 Hz to 13 kHz, distortion at 0.05% at one watt output.

Suggested price is $198 each. Distributed in Australia by Tradepower International Pty Ltd, 115 Whiteman Street, South Melbourne Vic. 3205. (03)690-6873.

Not Just Speaker Wire

Conventional speaker wire limits the performance of your sound system by decreasing power output, restricting dynamic range, and reducing clarity and definition. You can significantly improve the performance of your audio system by switching from your present speaker wire to Monster Cable.

Constructed of over 500 strands of high purity copper in a unique configuration, Monster Cable is specifically engineered for low resistance, low capacitance, and low inductance. The Results?

Deeper, tighter bass.
Maximum power transfer.
Increased clarity and definition.
Wider dynamic range.

Even low-powered systems show a remarkable improvement. Recommended by leading audio manufacturers, Monster Cable is safe to use with all amplifiers and receivers, regardless of design.

Don't be deceived by imitations. If it doesn't say Monster Cable you're not getting all the performance you paid for.

MONSTER CABLE

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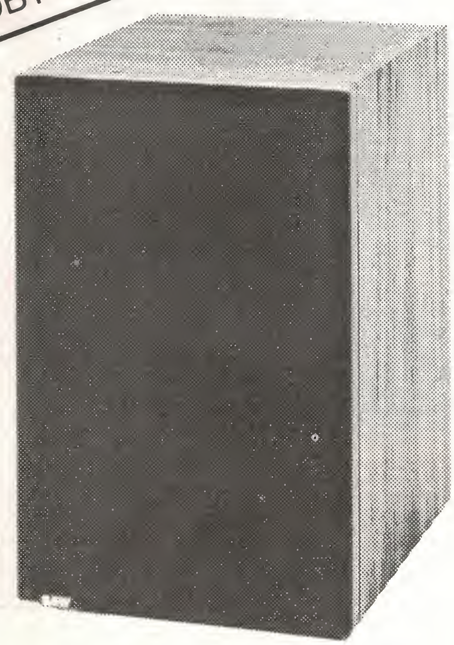
B&W DM12

THE UNOBTRUSIVE REVOLUTIONARY



We could have built something smaller, but we were determined to build a miniature speaker that rises way above the limitations hitherto imposed by a small enclosure. In particular, we wanted to achieve wider response and more realistic sound levels in the low frequency range.

We also wanted safe power-handling capacity. Thanks to our unique resources in computer and laser technology and the sheer creativity of our design team, DM12 achieves all this and more.

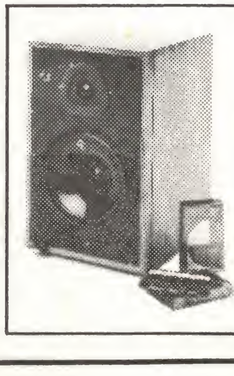
It's certainly small.
Just 355mm (14 in) high x 220mm (8¾ in) wide x 270mm (10½ in) deep.

106dB.
That's the surprising peak sound pressure level DM12 produces from its 12 litre enclosure.

Monitor standard.
Frequency linearity + 2 dB 85 Hz to 20kHz.

APOC-protected.
B & W's exclusive audio-powered overload circuit protects against accidental damage or overload.

B&W
LOUDSPEAKERS



For further information see your B &W dealer or contact
Convoy International Pty Ltd
4 Dowling Street Woolloomooloo NSW 2011
Telephone (02) 3582088

LIFESTYLE NEWS

New Audiogramme loudspeakers

Latest in the range from Australian speaker maker, Audiogramme, is the 'Series Two' AG model lineup.

There are four models in the range, designated AG 25, AG 45, AG 65 and AG 85.

The AG 25 is a compact two-way bass reflex system with a 215 mm bextrene cone bass-mid driver and a 25 mm soft-dome tweeter. Crossover is at 2.5 kHz and response is quoted as 50 Hz to 20 kHz. Impedance is 8 ohms and it measures 530 x 295 x 295 mm.

The AG 45 is a three-way bass reflex model measuring 700 x 295 x 295 mm. It uses the same bass-mid driver and tweeter as the AG 25 with the addition of a 19 mm soft mylar dome super tweeter. Crossovers are at 2.5 kHz and 10 kHz. Response is quoted as 45 Hz to 25 kHz and nett enclosure volume is 40 litres.

The AG 65 is an acoustic suspension type, unlike the rest. It is a three-way system employing the same drivers as the AG 45. Crossover frequencies are located at 2 kHz and 10 kHz. Response is quoted as 38 Hz to 25 kHz. Enclosure volume is 58 litres and impedance 6.5 ohms. The cabinet measures 790 x 330 x 330 mm.

'Flagship' of the range is the AG 85. This is a bass reflex enclosure measuring 760 x 355 x 355 mm employing a four-way system. Bass driver is a 265 mm bextrene cone unit, mid-range is a 60 mm soft polymer dome unit, while the tweeter and super tweeter are the same as employed in the other models. Crossover frequencies are located at 1.2 kHz, 3 kHz and 10 kHz. Response is given as 35 Hz to 25 kHz and the impedance as 8 ohms. This unit includes stands, whereas stands are optional on the others.

The speakers have input power ratings of 80 W, 100 W, 120 W and 150 W for the AG 25, AG 45, AG 65 and AG 85 respectively.

Further information from Audiogramme Loudspeakers, P.O. Box 24, Indooroopilly Qld 4068. (07) 369-9670.

Convoy get Systemdek

Just as we went to press, Convoy International were crossing their eyes and dotting the tees on an agreement to handle the Systemdek turntable in Australia.

Convoy will release the Systemdek II here this month. This unit features a 24-pole precision synchronous motor mounted on an anti-vibration assembly within the cylindrical housing that stands on three levelling legs.

The platter is belt driven and is quoted to start up in two seconds for audible stabilisation. Two speed operation requires manual change between 33 and 45 rpm.

The platter is a 1.73 kg 10 mm thick glass slab and the record mat is made of high density lambs wool. Wow and flutter is quoted as 0.09% DIN (peak, weighted), rumble as 78/77 dB (DIN B weighted) and hum as −72 dB (DIN B weighted).

It is expected to sell here for $399. A spirit level for setting it up can be obtained for $3.99 too. Details from Convoy International, 4 Dowling St, Woolloomooloo NSW 2011. (02) 358-2088.

Mini stereo

Sanyo's M-G10 is a rugged and light portable cassette player with positive, simple controls.

Weighing only 310 gms and 3.2 cm thick, M-G10 comes complete with a shoulder strap and carry case. A set of comfortable, foam-cushioned headphones lets you listen anywhere.

Tape heads are designed to give excellent stereo performance from all tapes, including metal. The unit has locking controls for fast-wind of the tape in either forward or reverse, and the automatic stop mechanism disengages the tape at the end of play.

Sanyo's M-G10 operates on three 'AA' size batteries or ac power with an optional adaptor. Suggested retail price is $78.

For further information, contact Mr. W. Fabiszewski, Sanyo Australia Pty Ltd, 225 Miller Street, North Sydney NSW 2060. (02)436-1122.

New Mordaunt-Short speakers

Further to the successful launch of the Mordaunt-Short Series 3 loudspeakers, Concept Audio, their Australian importer and distributor, has announced a new addition to the range.

This is to be known as the Ms-20 and will comprise identical components to the Carnival Series 3. However it will be housed in a conventional wooden box and finished in a black stain.

This new two-way loudspeaker system will have a recommended retail price of $398. Enquiries to Concept Audio, 22 Wattle Rd, Brookvale NSW 2100. (02)938-3700.

'Off the rack' stereo

Within a year or so we could be buying our hi-fi components off a rack packaged in a plastic bubble card.

The concept might appear ridiculous now, but after seeing what Technics has in store for us this coming year that possibility is not so ridiculous.

Technics plan to release a new midi hi-fi system this month in which all the components simply plug into each other. It does away with the need for RCA leads and a rat's nest of wiring in the rear of the components.

You simply buy an amplifier, then a tuner and plug the tuner into the top of the amplifier, each having specially located connection sockets.

The cassette deck, and any other hi-fi component like an equaliser, plugs in in the same way. It takes all the hassle out of installation.

In the initial release the components will all still carry their own power transformers and power cords and so will still need to have a Kambrook type power board.

But the next step could be to do away with the transformers in all the add-on components. One would need only a power transformer in the amplifier. The power supply for components would then be taken from the amp via the interconnecting 'bus' sockets.

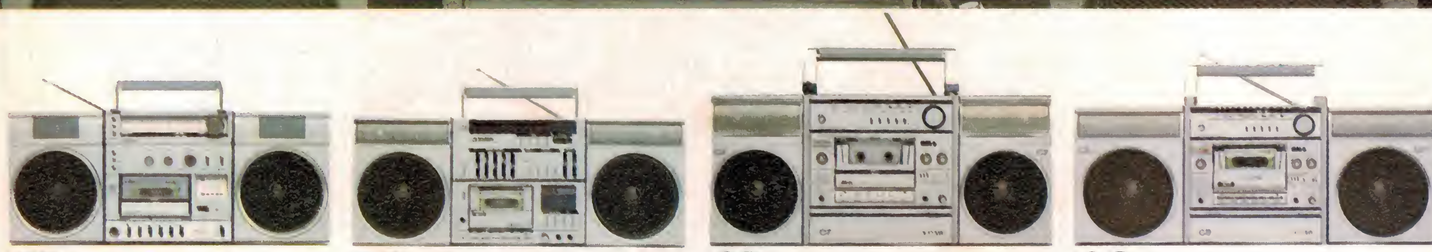
This would make them very light, much cheaper to produce, and could eventually lead to a self service supermarket type shop.

You simply select your hi-fi system in components and then plug one into the other for both power and audio. No wiring and no fuss installation.

The Technics 'midi system' is expected to sell under $1000 and is being described by Technics as "personal audio" because it will appeal mostly to teenagers looking for a sound system for the bedroom, or a young couple wanting a sound system for a flat in which space is at a premium.

The systems will have a minimum of 25 watts although consumers will eventually be able to select different amplifiers with different power performance.

Technics expect this personal audio to take around 30 per cent of the audio market quite quickly.



C3 C5 C7 C9

Up till now, about the only place you could hear great sound outdoors was at a rock concert.

SANYO
That's Life!

But now Sanyo has answered that problem beautifully, with a new range of portable Stereo Radio/Cassette Recorders, with detachable speakers. The quality of sound is, in a word, amazing.

So now, enjoying great sounds in the great outdoors, or anywhere else for that matter, is as easy as picking up one of these new Sanyos.

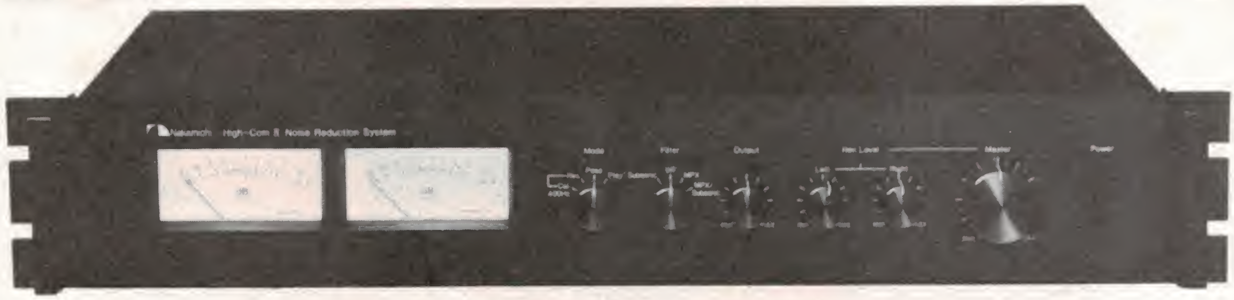
In addition, Sanyo are now distributors in Australia for Fisher Equipment, and we are pleased to announce their new range of portable Stereo Radio/Cassette Recorders, with detachable speakers.

Obviously, there's not enough room here to go into details, so we'd like to suggest you see your nearest Fisher retailer.

As they say, hearing is believing. But, that's life.

FISHER

Distributed by Sanyo Australia Pty Ltd



Nakamichi High-Com II noise reduction system

Is this the noise reduction system '. . . for all seasons? Very probably, for, apart from providing 20 dB of noise reduction and improved dynamic range for tape recorders of all sorts, the High-Com II can probably achieve adequate decoding for CX-encoded discs!

Louis Challis

IN THE LAST three weeks I have reviewed a number of excellent original half-speed mastered recordings from Mobile Fidelity in the States. Two of the most exciting of these are Earl Klugh's 'Finger Paintings' (MFSL1-025) and Respighi's 'The Festeromane — The Pines of Rome', starring the Cleveland Orchestra and Lorin Maazel (MSSL1-507). These records are typical of the latest generation of half-speed mastered microgroove records with imported pressings and superlative plating being produced in Germany, America and Japan. The real advantage of these records is not just the loving care and attention given to the original musical production, but more importantly the technological loving care given to their mastering, and most particularly to their pressing.

With all this attention, the maximum dynamic range that can currently be achieved on a conventional microgroove record, even with half-speed mastering recording in the studio and lots and lots of good luck, is about 65-68 dB. Obviously, with digital recorders capable of producing 96 dB of dynamic range, this falls somewhat short of the real dynamics that the medium is capable of producing. In most cases it even falls short of the best performance that your amplifier, and even your loudspeakers, are capable of producing.

NAKAMICHI HIGH-COM II NOISE REDUCTION SYSTEM

Dimensions:	*482 mm wide x 82 mm high x 270 mm deep*
Weight:	*5 kg*
Manufactured:	*by Nakamichi Corporation, Tokyo, Japan*
Price:	*$400*
Distributor:	

Early in the 1970s or thereabouts, a little known band of entrepreneurs in America, under the banner of Sheffield Laboratories, commenced recording and marketing direct-on-disk records whose technical excellence and music quality were just the sort of thing people like you and I were looking for to show off the *real* capabilities of our high fidelity systems. Obviously, direct-on-disk is very nice, but it is also very difficult to execute, relatively expensive and unusually complex for the musicians, who found, like Dame Nellie Melba back in the years of the pre-electronic recording, that if you were wrong, you were wrong, and had to start recording again from scratch.

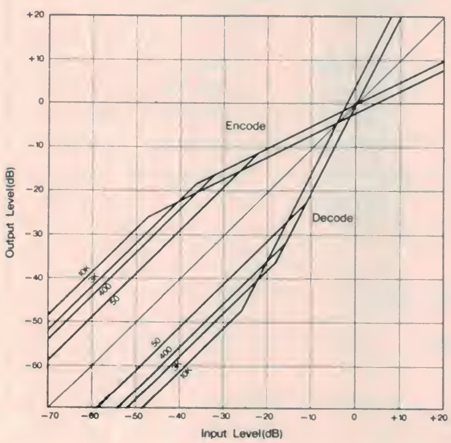
The development of digital recording has not really solved those problems, it has only exacerbated the difference between the best that the laboratory and studio technology can produce, compared with the modest yet reasonable dynamic range capabilities of the modern microgroove record. There is no point in having a digital recorder with a 96 dB dynamic range, a home hi-fidelity system with 100 dB dynamic range, and then a record with something between 50 and 68 dB of dynamic range, depending on which record you happen to buy, how clean it happens to be and a variety of equally significant other little factors which add up to a big difference in total performance.

Noise reduction systems

We have previously written about the Dolby A, B and the new Dolby C noise reduction systems, and also dbx, which have all played exciting and important roles in the development of tape recorders with superior signal-to-noise performance.

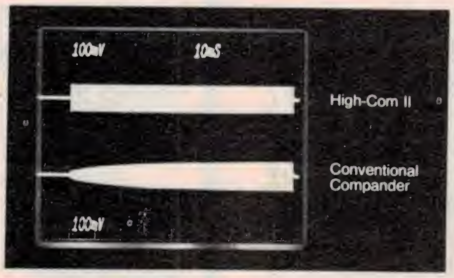
That's all very nice, of course, but by and large, with the exception of direct-on-disk and the best of the digitally encoded recordings, nobody has done very much about the microgroove recordings. (The possible exceptions, of course, are dbx with their specially encoded records, and AEG Telefunken of West Germany and Nakamichi, who together developed the High-Com system based on the Telcom C4D system).

The C4D system was developed for broadcast stations and recording studios, and was intended to provide the best features of dbx and, I suspect, some of the best features of the Dolby system as well. The High-Com system was developed some three or four years ago and the High-Com II is a more recent development which reached the Australian market in 1981. Surprisingly, more recently another equally important noise reduction system specifically developed for records has been released in America and is being pushed very solidly under the banner of the CX format. When I looked more closely at the CX concept and the High-Com II concept, I was amazed at the similarity of their encode/decode or compress/expand characteristics. These are both essentially based on the use of a 2:1 expansion and 1:2 compression ratio for signals normally falling within the −20 dB to +10 dB range.



Encoding-decoding characteristics of the Nakamichi High-Com II system. (From Nakamichi information brochure.)

The significant difference really between the High-Com II and the CX compression/expansion system is that the High-Com divides the audible spectrum up into two bands, with different threshold points for changing encoded to normal amplification threshold. Thus signals above 10 kHz



Deck 680
Tape ZX (Metal)
Freq 5KHz
Level − 10dB

Transient response of the Nakamichi High-Com II compared to a conventional compander. (From Nakamichi information brochure.)

have a 0.5 compression ratio which starts at −25 dB, the signals between 10 kHz and 3 kHz start at −18 dB, the signals down to 400 Hz start at −16 dB, whilst signals below 50 Hz start at −12 dB. This selective compression and expansion threshold point is designed to make best use of the dynamic range excursion characteristics, which can conveniently be encoded on either a tape recorder or on a conventional microgroove record. The major attribute claimed for the system is that it provides a genuine 20 dB improvement in signal-to-noise ratio, compared with either tape format or normal microgroove record format. More importantly, there is little penalty in terms of loss of compatibility with normal format, and the signal-to-noise improvement extends for the full frequency range of the recorded material, unlike with Dolby B or Dolby C. One could argue that this is a variation on the basic theme of the dbx system, but as it takes place over a somewhat more limited range, it maintains a basic similarity and compatibility with both tape recorder and conventional record formats.

Design and appearance

The High-Com II typifies the Nakamichi concept of design and appearance. The unit is really primarily intended for rack mounting as a sub-element associated with a tape recorder/amplifier system and, as Nakamichi will tell you, preferably with a Nakamichi cassette recorder. However, don't be misled; it can work with anybody's brand of recorder and with any type of tape recorder, i.e: reel-to-reel, compact cassette, micro-cassette or cartridge.

The front panel is finished in black with white engraving. On the left hand side are two VU meters, each reading from +10 to −40 VU and featuring rear illumination. In the centre of the front panel is a mode switch with four settings: 'record', which is the position used for encoding; 'pass', which allows signals to pass through the unit without encoding or decoding; 'playback', which is the decode mode for tape recorders; and 'disk', which is the decode mode for playback from a High-Com-encoded disk (or, as it transpires, is also most probably equally suitable for a CX-encoded disk).

Adjacent to the mode switch is the filter tone switch, which also has four positions, respectively: 'subsonic', which provides −10 dB of attenuation at 20 Hz and −40 dB of attenuation at 11 Hz; 'off'; a 'multiplex'position, which provides 35 dB of attenuation at 19 kHz; and a '400 test tone' position for provision of the internal level calibration and system alignment signal for use with either tape recorder or record player.

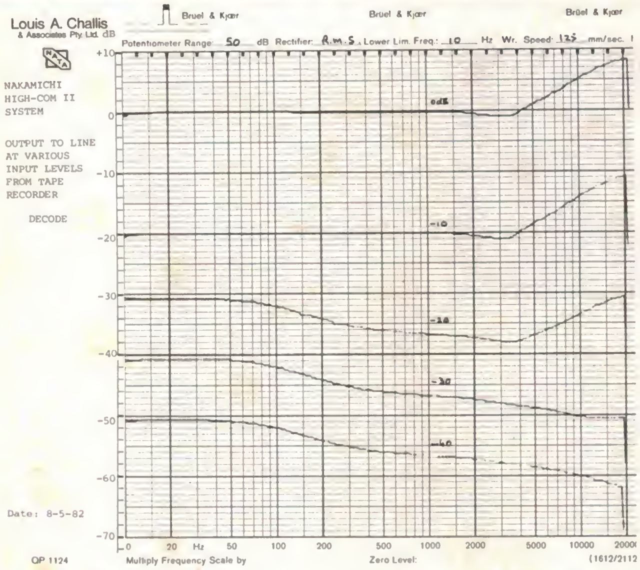
On the right hand side of the deck are two recording level controls for setting the record level and calibration level for left and right channels of tape recorders or High-Com or CX-encoded disks.

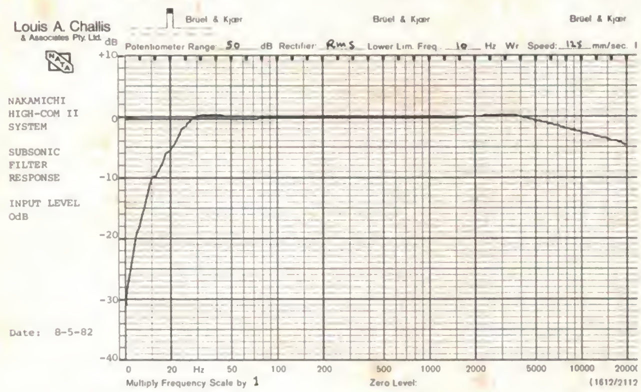
On the extreme right hand side of the front panel is a master volume control, which provides similar functions to the two adjacent recording level controls but within one single potentiometer. Adjacent to it is an illuminated power on/off switch.

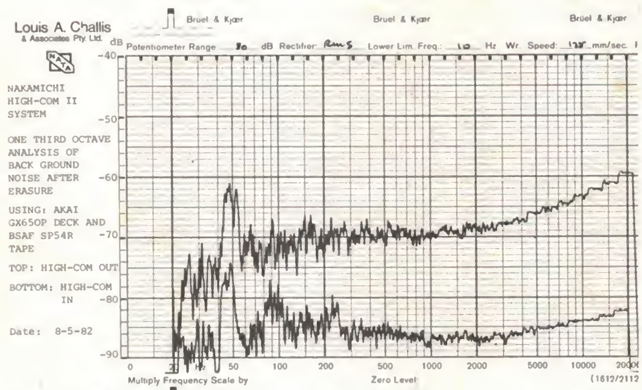
The rear panel contains four sets of coaxial line sockets, with four pairs of sockets for line in and line out and four pairs for connecting to a recorder. Adjacent to each of the recorder in and out sockets is a rotary calibration control for setting the correct operating point for the record and/or playback decode modes when using the internal calibration signal. All that is required to operate the system correctly is to patch it up with four pairs of coaxial leads to your amplifier, or amplifier and tape recorder, to achieve the full capabilities of its encode and decode capability.

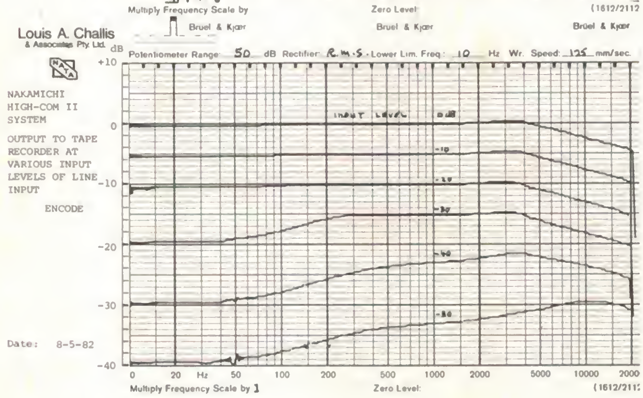
The inside of the unit features four large-scale socket-mounted 24-pin integrated circuits, twelve 8-pin integrated circuits and eleven transistors. These are mounted on one medium-sized printed circuit board, which encompasses approximately two-thirds of the chassis area. Only the transformer, the two VU meters and a few other components at the rear panel and on the front panel are separately wired through to the board. In typical ▶

SOUND review









MEASURED PERFORMANCE OF NAKAMICHI HIGH-COM II SYSTEM

SERIAL NO. 03142

FREQUENCY RESPONSE 20-20000Hz ±1dB

INPUT IMPEDANCE	LEFT	RIGHT
LINE	32k ohms	33k ohms
PLAYBACK	33k ohms	33k ohms

OUTPUT IMPEDANCE — LEFT — RIGHT

PLAYBACK MODE (decode)

(at OdB output level)

	63Hz	1kHz	6.3kHz	10kHz
2nd	-54.0	-56.2	-54.1	-53.8 dB
3rd	-64.4	-65.7	-63.5	- dB
4th	-70.9	-85.7	-75.6	- dB
5th	-80.2	-80.6	-	- dB
THD	0.21	0.16	0.21	0.20 %

(at +6dB output level)

	63Hz	1kHz	6.3kHz	10kHz
2nd	-52.8	-54.0	-57.6	-51.0 dB
3rd	-58.7	-60.4	-58.4	- dB
4th	-66.2	-82.5	-76.4	- dB
5th	-78.1	-77.9	-	- dB
THD	0.26	0.22	0.29	0.28%

INTERMODULATION DISTORTION

f_1 = 330Hz and f_2 = kHz mixed 4:1

DISTORTION component near 8kHz

COMBINED LEVEL AS INDICATED ON HIGH-COMM V.U. METRE.

LEVEL	$f_2 - 2f_1$	$f_2 - f_1$	$f_2 + f_1$	$f_2 + 2f_1$
+5dB	-49.3dB	-47.4dB	-54.5dB	-48.7dB
+3dB	-51.5dB	-48.3dB	-55.8dB	-50.5dB
OdB	-56.1dB	-50.6dB	-58.8dB	-55.5dB
-5.0dB	-62.9dB	-53.1dB	-64.1dB	-61.7dB
-10 dB	-65.0dB	-55.7dB	-	-67.2dB

COMPRESSION / EXPANSION RATIO

COMPRESSION	1:2 (see graphs)
EXPANSION	2:1 (see graphs)

SIGNAL TO NOISE IMPROVMENT (see curves)

AKAI	GX650P deck	17dB(Lin)	19dB(A)
SONY	TC-FX6C	18dB(Lin)	20dB(A)

Nakamichi thoroughness the printed circuit layout from the underside of the card is clearly printed on the front, as are all the component designations to simplify troubleshooting if and when servicing has to be performed.

Two things are clear: firstly that the special integrated circuits providing the High-Com function have been specially fabricated for this particular module, and secondly that the extent of the circuitry involved in the High-Com II system is more complex and more demanding in terms of its overall performance capabilities than the comparable CX circuit encoder/decoders (which are single-band rather than two-band devices). The main features the High-Com system offers are the two-band frequency selective encoding/decoding, and the ability to reduce the low frequency modulation of high frequency components during transients which are part of normal programme content. This is obviously more critical when recording onto cassette decks, where high frequency pre-emphasis and hiss problems are far more important than they are in the case of a record.

One obvious question that could be asked is, "To what extent is the High-Com system more useful than Dolby B or Dolby C?" In the case of Dolby B this is very easy to answer, as the High-Com circuit is capable of producing at least 12 dB more effective signal-to-noise ratio than is achievable on a Dolby B recorder. If one takes into account the greater headroom and top-end dynamic range of the High-Com system, then this figure can be increased to almost 18 dB.

On test

The objective testing of the High-Com II system was straightforward. The first set of results we produced was a set of level recordings showing the record mode or what might otherwise be called the encoding process for the High-Com. These show clearly how the primary compression in the mid-band region extends from typically 10 Hz through to 4 kHz, above which point a gliding increasing level of de-emphasis takes place to further reduce the amount of high frequency signal on the tape. In the range 30 dB to 40 dB a modified low frequency de-emphasis is introduced, so that the likelihood of low frequency modulation interacting with mid-frequency components above 100 Hz is reduced.

It is in this region that the 'anti-pumping' capabilities are provided, which are the means by which the tonal and frequency level balance for both singing and music is maintained.

The non-linearity of the curves is matched by a directly comparable inverse function in the playback or decode mode, which is shown on the expanded-range level recordings. The degree of expansion over the range −30 dB to 0 dB, together with the high frequency pre-emphasis, becomes quite pronounced for signals above 20-25 dB, whilst a consequent de-emphasis takes place for signals in the −30 dB range down to the lower-level signals.

Tape hiss (as well as record surface noise) is dramatically reduced, so that overall dynamic range is increased by more than 20 dB. To prove this more effectively, I decided to use a conventional reel-to-reel recorder in the form of an Akai GX650D, which is not equipped with any internal noise reduction system. I would have preferred to be able to record from input to output and output back to input on the High-Com system, but without a second unit this is not feasible. I found that the dynamic range for the A-weighted signal-to-noise ratio relative to 0 VU was expanded from a normal 55 dB up to a very much more desirable 74 dB, whilst the true total dynamic range was expanded to 85 dB relative to the 3% third harmonic distortion. An 85 dB dynamic range is not to be scoffed at, and I was very impressed.

I repeated this exercise on a Sony TCFX6C and was even more surprised to find that the enhancement took the form of an effective reduction in the level of mains frequency signal, so that the unweighted noise level improvement relative to 0 VU was 18 dB and the A-weighted improvement 20 dB.

An equally important factor that required assessment was of course what the distortion characteristics would be during either decode or playback mode at say, 0 dB or +6 dB relative to normal output. I was pleased to find that the highest level of distortion measured at 0 dB was 0.21%, whilst at +6 dB it was still only 0.29%. These are excellent figures, so my next concern was whether a similar performance would be achieved for intermodulation distortion, which in a device of this type, with so many changes or non-linearities of frequency response, might well prove to be troublesome. This test was performed at levels of +5, +3, 0, −5 and −10 dB. The highest level of an intermodulation distortion product that I could measure was −47.4 dB at the f_2-f_1 frequency at +5 dB, and −55.7 dB at −10 dB. Over the range +5 to −10 VU there was a slow but small improvement in intermodulation distortion, but the level of the intermodulation distortion products was nonetheless excellent and generally less than 0.4%, becoming almost immeasurable at most of the intermodulation frequencies below −10 VU.

All the other parameters proved to be within the manufacturer's specification and therefore no cause for concern.

Subjectively

The acid test of any system in the end is the listening test. I continued the testing of the High-Com system with a series of cassette recorders, tape recorders and most particularly with the Nakamichi demonstration test record. This is pre-encoded with the High-Com II record characteriestics, so that on playback a dynamic range in excess of 86 dB is theoretically possible. The demonstration record has been made in America, not Japan, and the choice of music is excellent. I spent more than an hour of rapturous listening and re-listening to the record to convince myself that I was listening to a record and not to a digital tape. That record convinced me that the High-Com II system really does work, does almost everything claimed for it, and that in most respects offers an unquestionably superior performance (at a significant price penalty) when compared with Dolby B, Dolby C and even the best of the dbx systems.

This system, of course, is designed to be used principally with tape format, whilst the CX system that CBS has just started marketing is designed to be used only with records.

Summary

The High-Com II system really works. It does its job better than I would have expected, the only disadvantage being that we have another noise reduction format to add to five existing formats, with a sixth, the CX system, soon to be added. The one grace-saving feature here is that I suspect the High-Com system will be almost fully compatible with the CBS CX system, and if this proves to be so, then by purchasing this unit you may well save yourself the cost of a CX decoder, whilst at the same time being able to produce your own High-Com-encoded tapes. ●

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HUNTER USERS' GROUP: All microcomputers. Meets on the second Wednesday of every month, Room 308, Building W, Newcastle University, 7.45 pm. Members are mainly hobbyists with Apples, etc. Interested persons contact the Secretary, P.O. Box 39, Broadmeadow NSW 2298.

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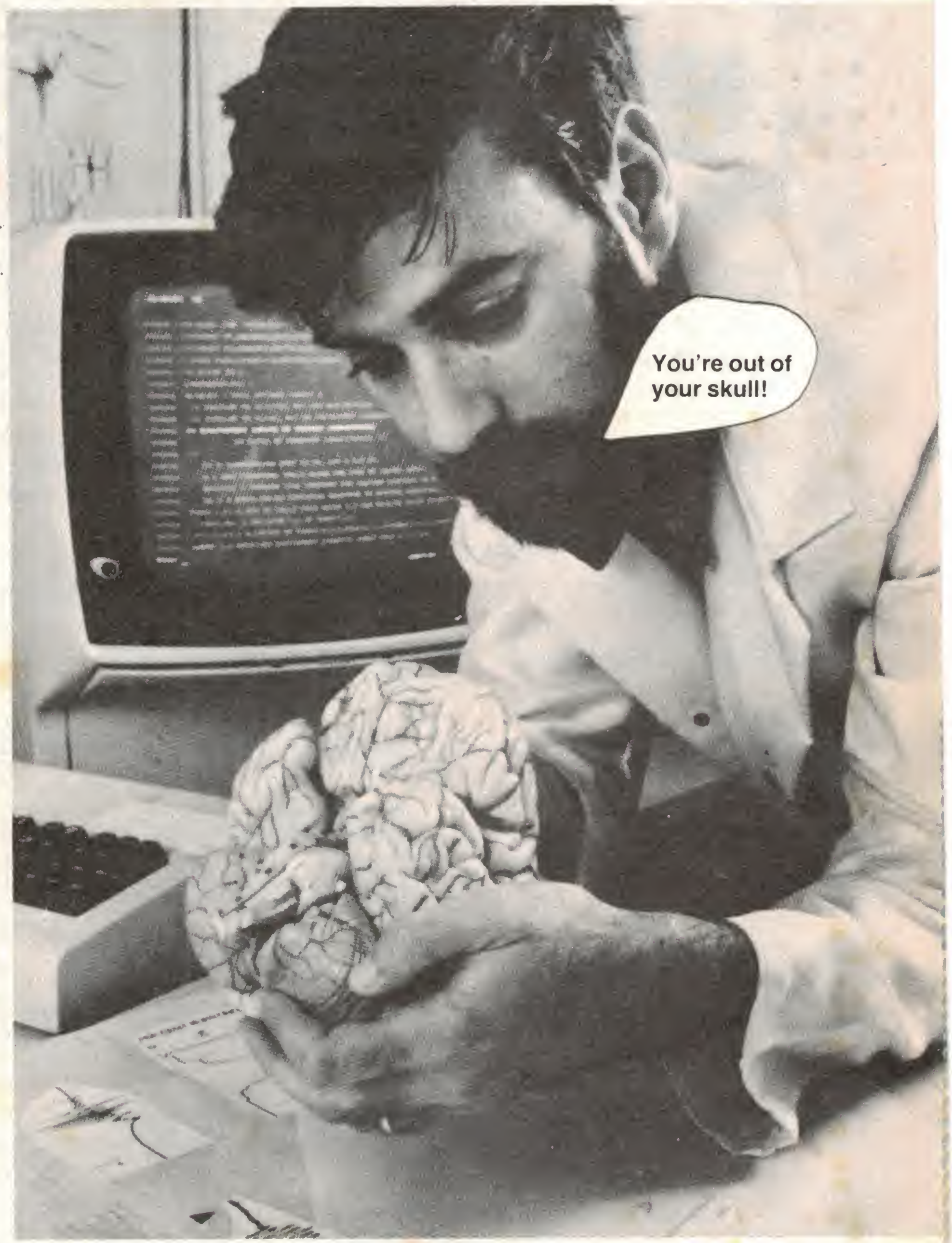

IT CAN BE AMUSING to ponder the 'what if?s' of this life. Take for example, a situation involving the inventor of the principle behind our 'photophone' project this month (ETI-918, page 25). To save you whipping through the pages, I'll tell you who it was — none other than Alexander Graham Bell, better known for his invention of the telephone. And probably one of the most-cursed men in history, the telephone being both a beast and a blessing. Anyway, ponder a moment on this 'what if?'.

If the Saxes (that Germanic race of people, also called Saxons, who once conquered Britain) . . . yes, what if the Saxes had beaten Alexander Graham Bell to his invention? Would we all be using Saxephones instead of telephones?

Twisted that a bit, didn't I. Well, Bell gave his name to the unit of loudness — the Bel. The most convenient form we know as the decibel. Now, what if the Saxes . . . etc? Would we be using decisaxes instead of decibels?

Let's try somebody else. Mr Heinrich Hertz for example. The man who proved Maxwell's electromagnetic theory was worth more than the paper it was printed on. He gave his name (. . . though posthumously) to the unit of frequency.

But what if a gentleman by the name of Pound had proved Maxwell's electromagnetic theory? Today we'd probably be talking about a hi-fi amp's frequency response extending from 20 Pounds to 20 kilopounds! Oh, Mother. That would have really stuffed the Metric Conversion Board (now defunct) right up! At least they didn't put Hertz's name to the unit of frequency so they would have, at least, had someone to blame.

Consider Georg Ohm. Wonderful fellow. Persistent, he was, in experimenting with the electrical resistance of wires of differing composition under the most arduous of circumstances in his draughty lodgings. But what if his name was Throssell? How would you feel walking into the local electronics store and asking for "a 39 kilothrossell resistor, please"? It hardly bears thinking about. Except in Dregs, of course.

Take that famous team who invented the transistor: Shockley, Bardeen and Brattain. No doubt many of you have had to regurgitate the names of that trio in an examination at some time or another. But, what if their names were Martin, Barton and Fargo? How would you cope with the all-too-common mental block in an examination when asked to name the team who invented the transistor and you could recall the first two names but only that the last started with F. . . . .?

What is your turntable's "warp factor"?

You may not realize it but every record has some degree of warp. And no matter how slight, it can give your turntable fits.

Warp, along with off-centring, were the reasons why Sony invented Biotracer.

The continuously correcting action of the electronic Biotracer tonearm perfectly suspends the stylus in the record grooves with no tension resulting from the forces of gravity or lateral pressure.

Biotracer is featured on Sony's PS-X600 and X500 with the advantages of stifling low frequency resonance, expanding dynamic range and maximizing performance from any cartridge you use. Biotracer also suppresses peak tonearm resonance electronically within a range of 3dB.

The sole object of its design was to neutralize the effects of record warp and off-centring through microcomputer precision. Which Sony does with aplomb.

PS-X600

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The biggest problem with most computer accounting packages is just that – they're packages. Designed to suit 'The Average Business'. Which probably isn't your business.

The MiniMicro Accounting Package is unique. It has all the power and features of other accounting packages, but without the restrictions. You don't have to fit your accounts into our system – we fit our system around you. So that you can get the information you need to keep your business running.

That's why Ken Middleton of MiniMicro Supermart, the man who designed the MiniMicro Accounting Package, is the man you'll deal with. Each installation is fully custom written around the framework of a powerful, easy to use accounting system. And it's not like other 'custom' software that takes months to write and costs "about $???". Full implementation of the MiniMicro Accounting Package takes two to three weeks and costs $1500. That's it.

And because you're dealing with the man who'll write your package, there are no communications breakdowns.

The MiniMicro Accounting Package is a completely menu driven General Ledger/Debtors system with provision for Creditors as part of the Chart of Accounts. It will run on most CP/M based microcomputers. A large range of suitable hardware is available from MiniMicro Supermart.

And good news for accountants. The MiniMicro Accounting Package is designed for easy implementation in an accountant's practice.

So if you need to computerise your accounting, but you're not impressed with the capabilities or price of systems you've seen, give us a call. Let Ken show you how the MiniMicro Accounting Package can help solve your accounting problems – instead of giving you new ones.

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